BAYOU TECHE WATERSHED IMPLEMENTATION PLAN

Dissolved Oxygen, Nutrients, and Fecal Coliform
060205, 060301, 060401, 060501,

INTRODUCTION

This document contains 2 Implementation Plans for the Bayou Teche waterway. One is for dissolved oxygen (DO) and nutrients and the other is for fecal coliforms. The Louisiana Department of Environmental Quality (LDEQ) and the Environmental Protection Agency (EPA) developed Total Maximum Daily Loads (TMDLs) for DO, nutrients, and fecal coliforms. A TMDL report adds up the pollutant loading in the waterbody and determines how far it exceeds the pollutant standards. In Louisiana, the report discriminates between point source loading and nonpoint source (NPS) loading. If the waterbody exceeds the standards, the TMDL can require lower LPDES permit limits for point sources, however, NPS runoff often represents most of the pollutant load into many of our waterways. A watershed Implementation Plan is used to address the reduction of NPS pollution. The primary goal of this Implementation Plan is to reduce the NPS loads within the impaired watersheds until those waterbodies meet their designated uses and water quality standards are obtained. In agricultural watersheds, such as the Bayou Teche, the implementation of conservation tillage, filter strips, and other Best Management Practices (BMPs) are the recommended course of action for reducing pollutant runoff from row crops, rice, and pasture. Hydro-modification, home sewerage, and urban runoff also contribute to low DO conditions and high fecal coliform counts. BMPs for these NPS pollutant sources will be presented in this plan as well. The following text describes the Bayou Teche sub-watershed and its pollution problems and proposes a plan of action to remediate non-point-runoff in the watershed in order to meet the water quality criteria required by the state and federal regulations.

TMDL FINDINGS FOR DO

Since the Bayou Teche is a narrow watershed with very little drainage area, the TMDL for the Bayou Teche did not model for non-point source (NPS) pollution nor did it specify any reductions for nonpoint source pollution. The TMDL concluded that: "*Bayou Teche has natural levees which convey nonpoint sources away from the Bayou. The sources for nutrients and oxygen demanding substances in the Bayou Teche are upstream watersheds, Bayou Cocodrie and the Atchafalaya Basin…. The implementation of best management practices in the Bayou Cocodrie watershed and the Atchafalaya Basin to control and reduce the runoff of soil and oxygen-demanding pollutants from nonpoint sources will also control and reduce the nutrient loading entering the Bayou Teche watershed. The primary nutrient source is the Atchafalaya Basin which has the Mississippi as its primary source. The key to reducing nutrient loading in Bayou Teche is the reduction of nutrient loading to the Mississippi.*" Therefore, the TMDL does not offer any specific reductions for NPS pollution in the four subsegments along Bayou Teche. Nevertheless, this Implementation Plan addresses the sources of NPS pollution and best management practices (BMPs) to reduce NPS runoff.

TMDL FINDINGS FOR FECAL COLIFORM

The Bayou Teche and its tributaries fail in both primary and secondary contact recreation for fecal coliforms; however, the bayou meets criteria for drinking water supply. The load reduction needed to meet the water quality standard for primary contact recreation in the watershed during the recreational period (May 1 – October 31) is 83% reduction. For secondary contact during the non-recreational period (November 1 – April 30), the load reduction needed is 73% reduction.

FEDERAL AUTHORITY

Section 319 of the Clean Water Act (PL 100-4, February 4, 1987) was enacted to specifically address problems attributed to nonpoint sources of pollution. Its objective is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters (Sec. 101; PL 100-4), which instructs the Governor of each State to prepare and submit a Nonpoint Source Management Program for reduction and control of pollution from nonpoint sources to navigable waters within the State by implementation of a four-year plan (submitted within 18 months of the day of enactment).

STATE AUTHORITY

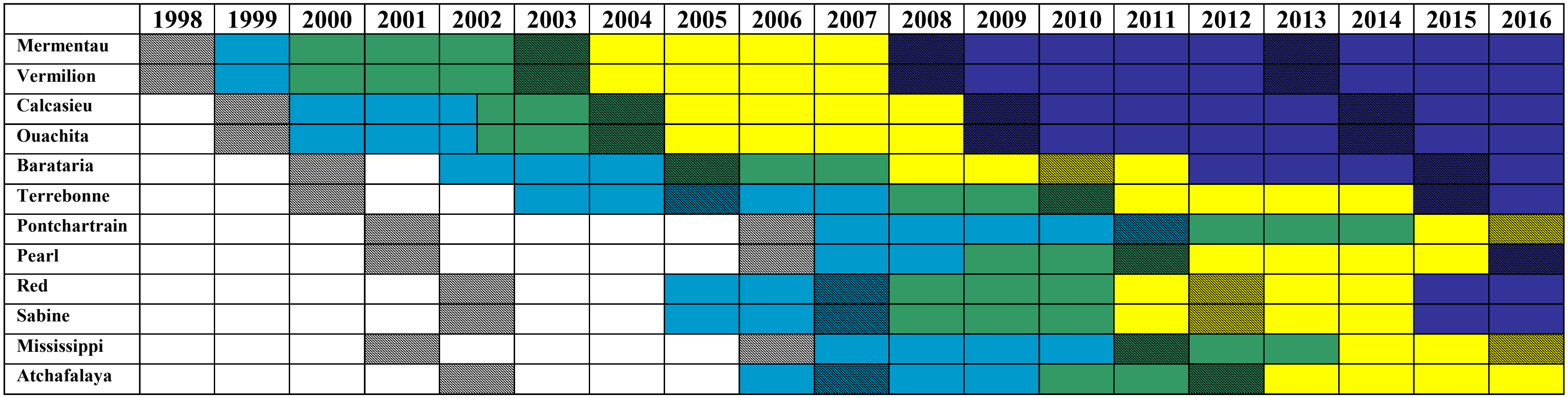
In response to the federal law, the State of Louisiana passed Revised Statute 30:2011, signed by the Governor in 1987 as Act 272. Act 272 designated the Louisiana Department of Environmental Quality as the "Lead Agency" for development and implementation of the State's Nonpoint Source Management Plan. The Louisiana Revised Statutes R.S. 30:2011.D (20) include the following provision as the authority for LDEQ to implement the State's NPS Program.

To develop and implement a non-point source management and ground water quality protection program and a conservation and management plan for estuaries, to receive federal funds for this purpose and provide matching state funds when required, and to comply with terms and conditions necessary to receive federal grants. The nonpoint source conservation and management plan, the groundwater protection plan, and the plan for estuaries shall be developed in coordination with, and with the concurrence of the appropriate state agencies, including but not limited to, the Department of Natural Resources, the Department of Wildlife and Fisheries, the Department of Agriculture and Forestry and the State Soil and Water Conservation Committee in those areas pertaining to their respective jurisdictions.

TIMELINE FOR IMPLEMENTATION PLAN

This Implementation Plan for the watershed restoration actions will be submitted to the EPA. This document outlines a 5-year management plan to reduce NPS pollutants from reaching the waterways. The LDEQ water quality team intensively samples each watershed in the state once every 5 years to see if the water bodies are meeting water quality standards. This 5 year cycle of water quality sampling began in 1998 in the Bayou Teche and will occur again in 2003, 2008, and 2013. In 2003, LDEQ will sample the bayou to see if there has been any improvement since 1998. In 2008, LDEQ will sample again in the watershed to see if the waterway has improved as the result of BMPs recommended in the Watershed Implementation Plan. If not, LDEQ will revise the Implementation Plan to include additional corrective actions to bring the waterway into compliance. Additional BMPs will be employed, if necessary, beginning in 2009 and increased until water quality standards are achieved by 2013. The long-term goal for restoring the waterway is 2015. The data from 2003 will be considered baseline from which to measure the rate of the water quality improvement in samples taken in subsequent years. The data collected in 2008 will be used to determine if the implementation of management measures in the Implementation Plan have been effective and whether additional corrective actions will need to be implemented until the water body meets criteria by the year 2015.

Revised Timeline for Watershed Planning and Implementation



1- Black Stripes = Collect Water Quality Data to Develop Total Maximum Daily Loads (TMDLs) and to Track Water Quality Improvement at the Watershed Level **[Objective 1**]
2- Light Blue = Develop Total Maximum Daily Loads for the Watersheds on the 303(d) List [**Objective 2]**
3- Green = Develop Watershed Management Plans to Implement the NPS Component of the TMDL **[Objective 3]**
4- Yellow = Implement the Watershed Management Plans **[Objectives 4-8]**
5- Dark Blue = Develop and Implement Additional Corrective Actions Necessary to Restore the Designated Uses to the Water Bodies **[Objective 9-10**

1.5 DESIGNATED USES

Table 1.1 Summary of designated uses and water quality information for the Bayou Teche waterway

Waterbody Bayou Teche Subsegment	NPS related parameters for which numerical standards have been developed	Standard (From LDEQ Environmental Regulatory Code) [3]	Does waterbody meet standard? (From 2000 305(b) Report)	Suspected sources that contribute oxygen demanding materials, nutrients, and pathogens to the Bayou Teche waterway
060205	Primary Contact Recreation Secondary Contact Recreation Dissolved Oxygen	[1] [2] 5 mg/l	No Yes No	Pathogens: minor municipal and industrial point sources, agriculture, urban areas, and natural sources. DO: oil and grease, organic enrichment, suspended solids and turbidity, minor municipal and industrial point sources, agriculture, and septic tanks.
060301	Primary Contact Recreation Secondary Contact Recreation Dissolved Oxygen	[1] [2] 5 mg/l	No Yes No	Pathogens: Same as above. DO: same as above with the addition of removal of riparian vegetation, and petroleum activities.
060401	Primary Contact Recreation Secondary Contact Recreation Dissolved Oxygen	[1] [2] 5 mg/l	No Yes No	Pathogens: Same as above DO: same as above with the addition of removal of riparian vegetation, petroleum activities and channelization.
060501	Primary Contact Recreation Secondary Contact Recreation Dissolved Oxygen	[1] [2] 5 mg/l	Yes Yes No	Pathogens: Same as above DO: same as above with the addition of removal of riparian vegetation, petroleum activities and channelization.

[1] Based on a minimum of not less than five samples taken over not more than a 30-day period. Fecal coliform count should be less than 200 /100ml over a 30-day period, and less than 10 % of samples during any 30-day period or 25 % of total samples collected annually can exceed 400/100ml. Applies only May 1 – Oct. 31, otherwise, criteria for secondary contact recreation applies.

[2] Based on a minimum of not less than five samples taken over not more than a 30-day period Fecal coliform count should be less than 1000 /100ml in at least 5 samples taken over a 30-day period, and less than 10 % of samples during any 30-day period or 25 % of total samples collected annually can exceed 400/100ml.

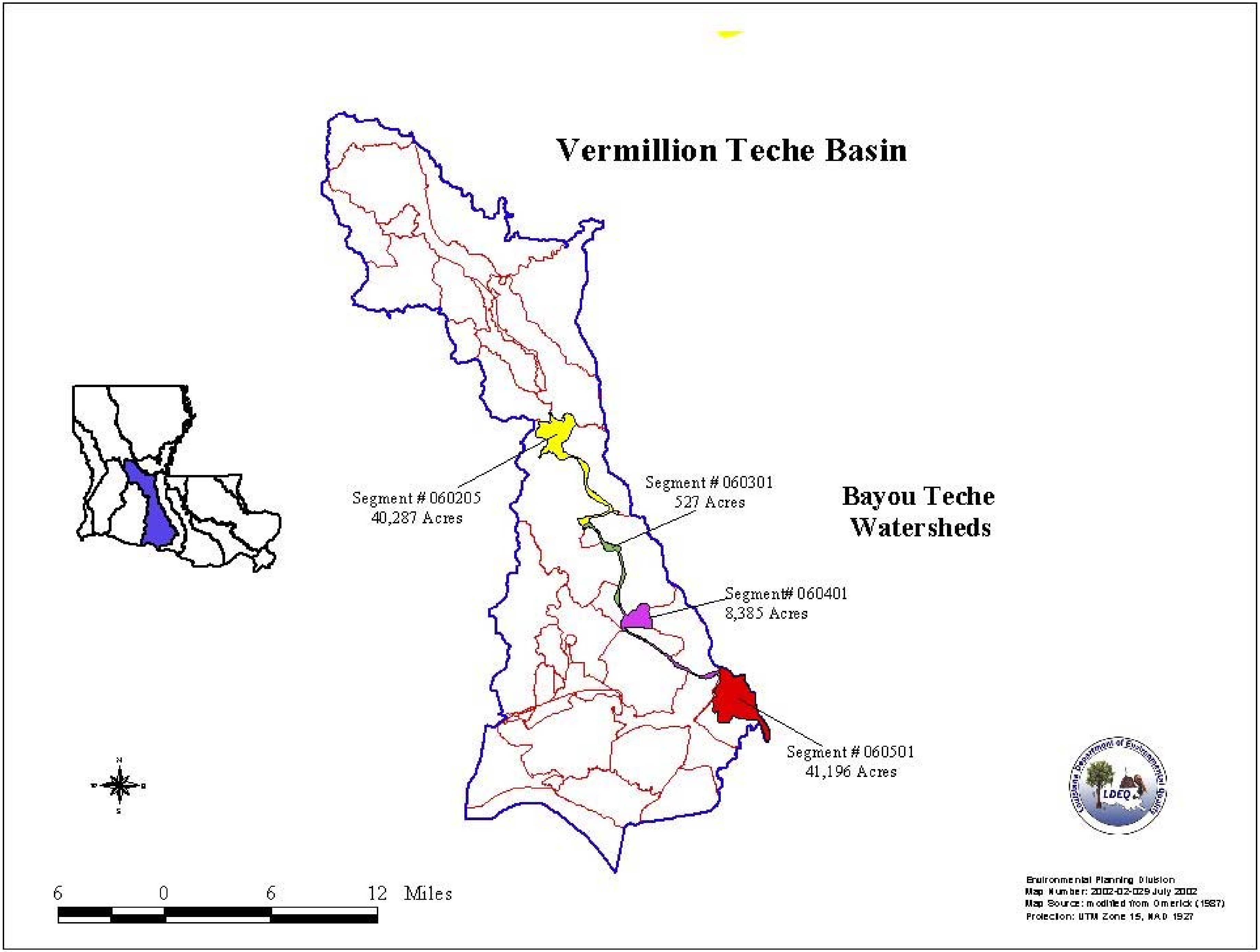
[3] It should be noted that TMDL listings were based on information dating back to 1992. A waterbody may meet standards for a particular constituent in the 2000 305(b) Report, but may require a TMDL due to failure to meet standards in a previous year. In addition, a waterbody may be listed due to its failure to meet certain narrative criteria.

DESCRIPTION OF WATERSHED

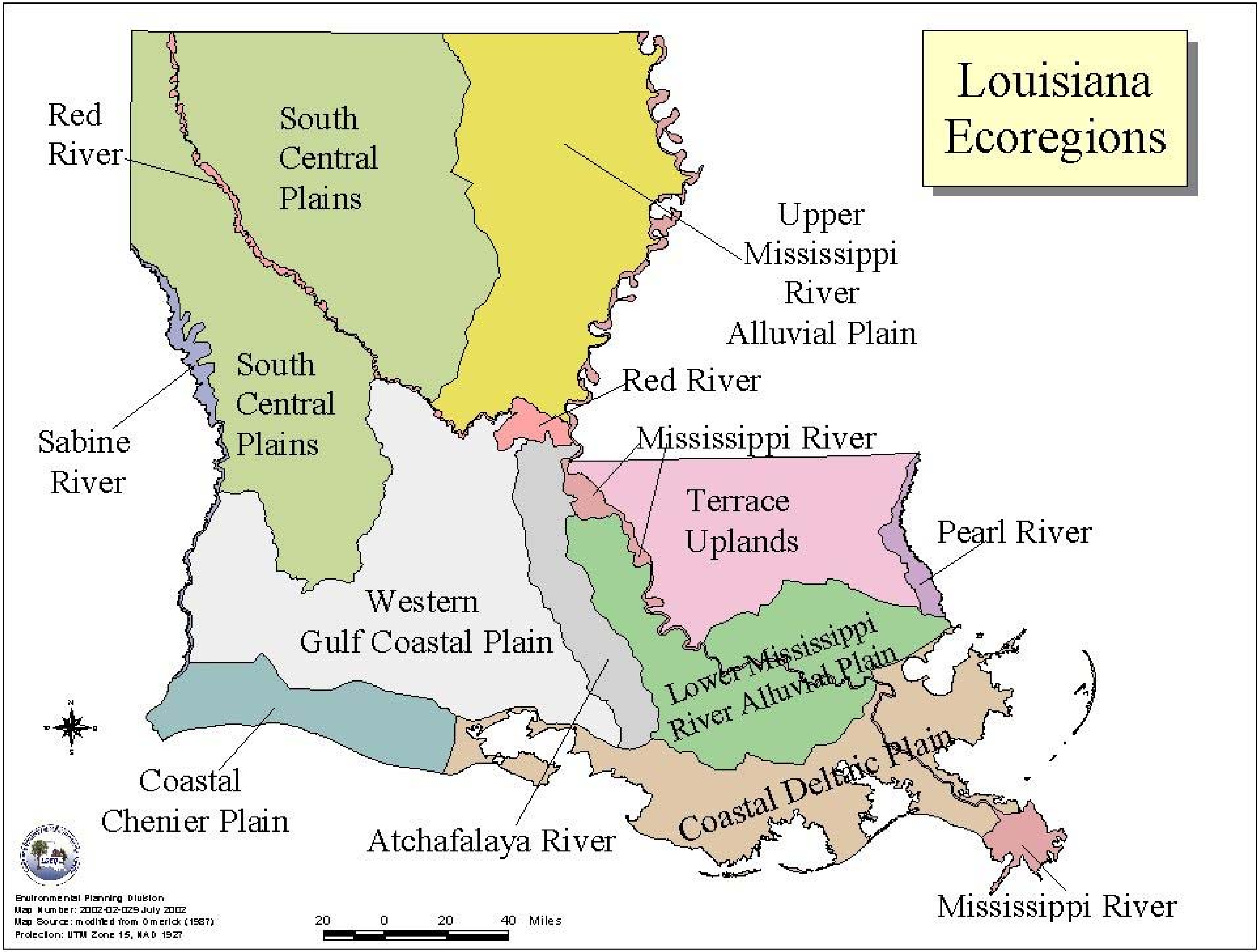
The Bayou Teche flows along the highest part of an alluvial ridge and is largely contained by a natural levee system. It is similar to the Mississippi in that the natural levee conveys nonpoint runoff away from the river system. Bayou Teche is a distributary in that it acts like a flume which channels flow from Bayou Cocodrie and Bayou Courtableau to the Vermillion river via the Ruth Canal and Bayou Fusilier. Loreauville Canal drains some of Bayou Teche waters into Lake Fausse Point before the Teche flows into the Wax Lake outlet that drains into the Gulf of Mexico. A multitude of other tributaries drain into Bayou Teche including Bayou Toulouse, Little Teche, Del Puent, Tortue, and Nelson, Pharr, and Sandager Canal.

The Bayou Teche is 125 miles long and much of the drainage area to the waterway is limited to the immediate shores. The watershed stretches to about 500 m on both sides of the bayou where it is confined by a natural levee. Throughout this reach, it meanders through many townships and cities such as New Iberia, Jeanerette, and Franklin to name a few. Bayou Teche is characterized by an alternating depression ridge, which results in slow flow rates and creates the formation of standing water and lakes during much of the year. The watershed receives about 56 inches of precipitation a year. The narrow watershed is mostly settled with residential homes and yards with intermittent agricultural lands. Agriculture in the southern half of the watershed is almost exclusively sugarcane. Soybean, rice, pasture and sugarcane are grown in the northern half.

LDEQ divides the Bayou Teche into four water quality management sections, subsegments 060205, 060301, 060401, and 060501. Historically, Bayou Teche received extensive channelization since it had served as the main artery of commerce and transportation for the region (USACE, 1986). Continued development in the Teche River Basin has required dredging of the bayou for flood control management, crop irrigation and in some instances navigation. Channelization has created uniform water depths and reduced flow gradients and velocities. All of these hydromodification activities have affected DO levels in the reaches of the Bayou Teche.



Vermillion Teche Basin
Bayou Teche Watersheds
Segment # 060205
40,287 Acres
Segment # 060301
527 Acres
Segment# 060401
8,385 Acres
Segment # 060501
41,196 Acres
6 0 6 12 Miles
Environmental Planning Division
Map Number: 2002-02-029 July 2002
Map Source: modified from Omernick (1987)
Projection: UTM Zone 15, NAD 1927

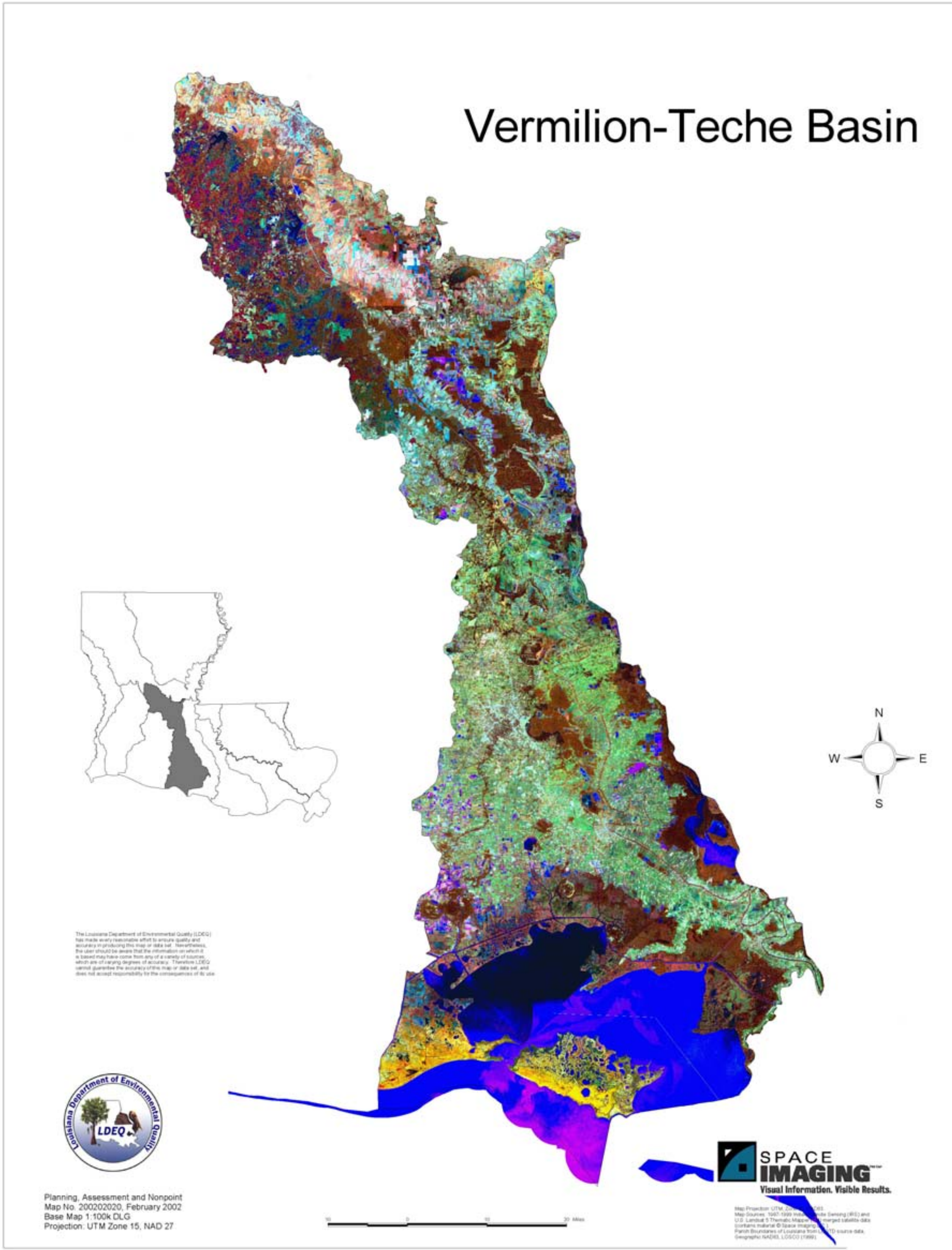

Louisiana Ecoregions
Red River
South Central Plains
Upper Mississippi River Alluvial Plain
Red River
Mississippi River
South Central Plains
Sabine River
Terrace Uplands
Pearl River
Western Gulf Coastal Plain
Lower Mississippi River Alluvial Plain
Coastal Deltaic Plain
Coastal Chenier Plain
Atchafalaya River
Mississippi River
Environmental Planning Division
Map Number: 2002-02-029 July 2002
Map Source: modified from Omernick (1987)
Projection: UTM Zone 15, NAD 1927
20 0 20 40 Miles

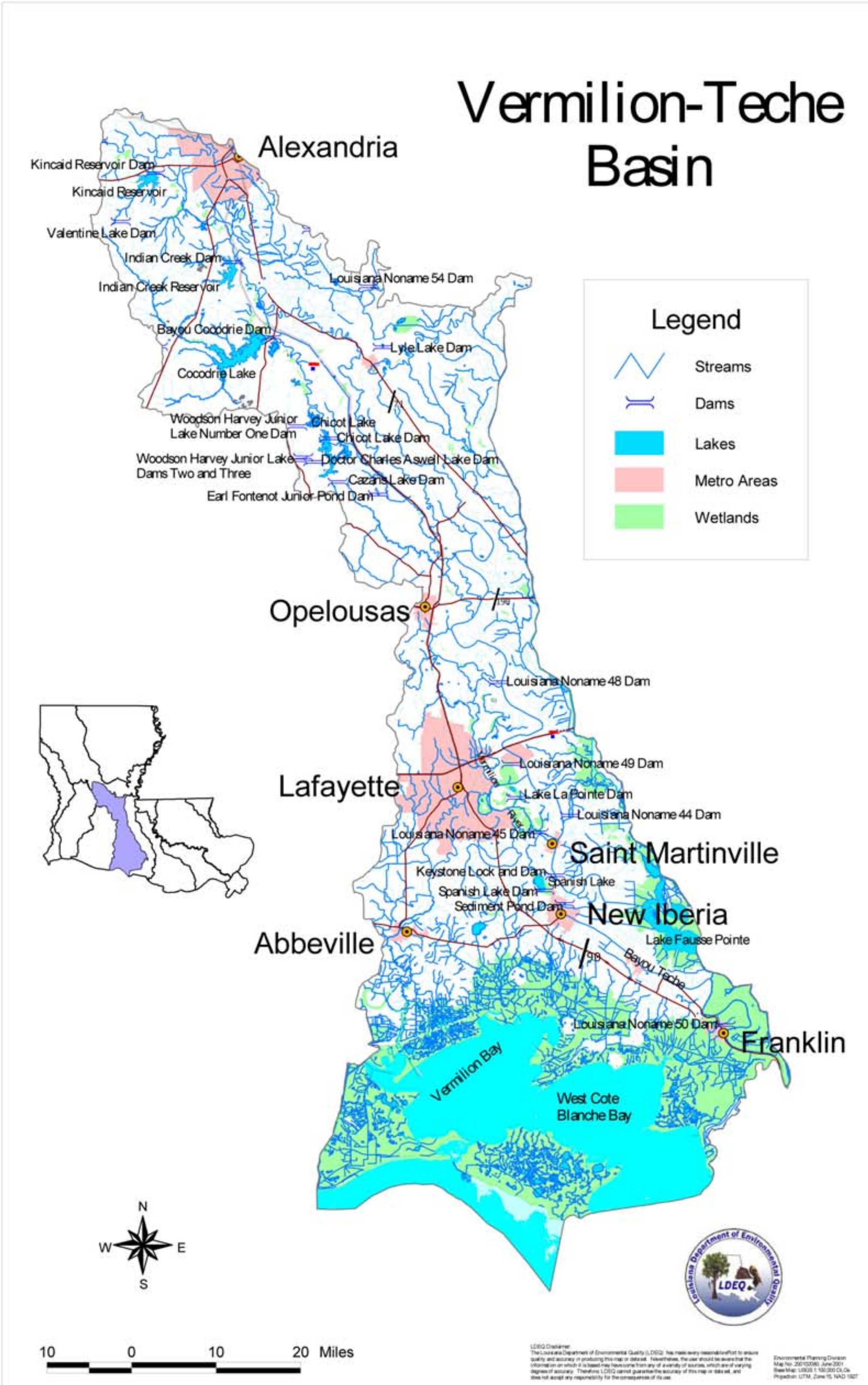
DESCRIPTION AND MAP OF ECOREGION

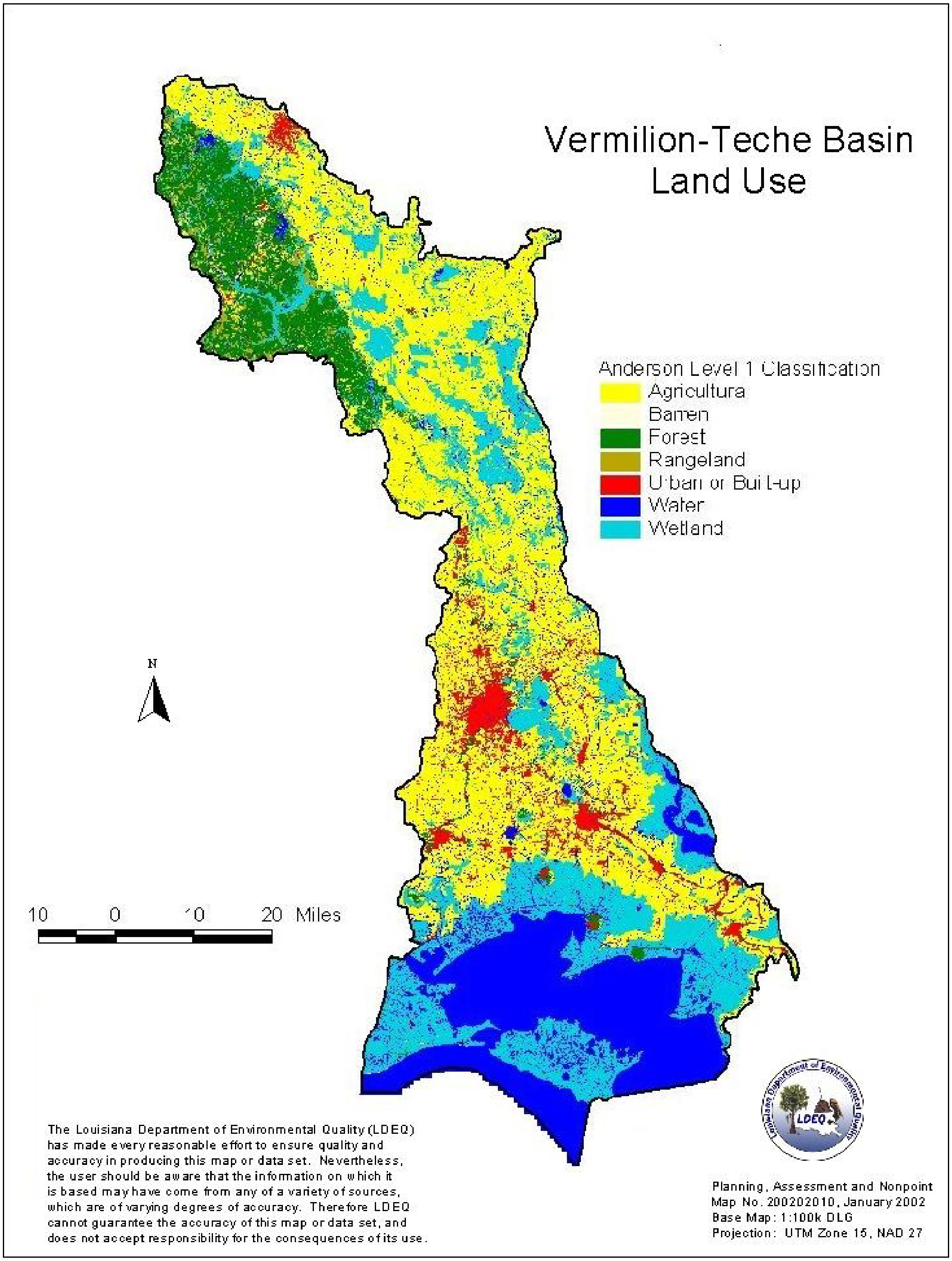
The Bayou Teche watershed is located in the Western Gulf Coastal Plain Ecoregion (WGCPE). The WGCPE lies between the southern boundary of the South Central Plains Ecoregion (SCPE) and the Coastal Chenier Plain Ecoregion to the south. The WGCPE consists of several vegetation types including, at its transition with the SCPE, longleaf pine flatwoods. Historically, 60-70% of the WGCPE has been a seasonally wet prairie (Brown 1972). The prairie was maintained as a mosaic of treeless plains and treed river corridors by the presence of an impermeable, calcareous clay layer that prevented percolation downward or capillary action of water upward into the shallow soils. Disjunction of this clay layer at stream margins allows trees to grow for a few hundred feet on either side of the stream. The clay allows water to stand during wet seasons, permitting the dominant landuse of the area, rice culture (Brown 1972).

BASIN AND ECO-REGION

The Vermilion-Teche Basin has many physical and hydrological characteristics and features common to both the Mermentau and Calcasieu River basins. All of these basins lie predominately within Louisiana's Western Gulf Coastal Plain (WGCPE) ecoregion. Marshlands are the major land features in the southern portion of the basin and prairie land predominantly characterizes the northern half of the basin. The basin begins at the western terminus of the Mississippi River floodplain along the Teche Ridge and is bounded by the West Atchafalaya Basin Protection Levee (WABPL) to the east and the Mermentau River Basin a short distance to the west. Located in south central Louisiana, this basin contains three major waterways, the Vermilion River and Bayou Teche in the southern area and the Bayou Boeuf watershed in the northern area. The Vermilion-Teche basin has flood plains which average only about 30 feet above sea level, ranging from less than 25 feet above mean sea level (msl) in the southern end of the study area to about 90 feet above msl in the headwater area of Bayou Boeuf (USACE, 1998). As in both the Mermentau and Calcasieu River basins, the Vermilion-Teche basin is subject to backwater flooding along waterways as a result of the low relief and flat contour of the land. Swamps and bayous of the region exhibit naturally dystrophic conditions with slow flows that result in lower reaeration rates. Channelization for flood control and control structures for saltwater intrusion (and in some instances navigation) has created uniform water depths, reduced flow gradients and velocities in the Mermentau, Calcasieu and Vermilion-Teche River Basins. Additionally, DO concentrations are directly related to water temperature. The most severe DO depletions occur at higher water temperatures. Therefore, the lower DO concentrations (less than 5 mg/L) associated with naturally dystrophic waters typically manifest seasonally during the warmer months of the year. Seasonal depletion of DO is also related to physio-chemical, hydrological, and geological characteristics.


Vermilion-Teche Basin
N
W
E
S
SPACE IMAGING
Visual Information. Visible Results.
LDEQ
Planning, Assessment and Nonpoint
Map No. 200202020, February 2002
Base Map 1:100k DLG
Projection: UTM Zone 15, NAD 27


Vermilion-Teche Basin
Legend
Streams
Dams
Lakes
Metro Areas
Wetlands
Alexandria
Opelousas
Lafayette
Saint Martinville
New Iberia
Abbeville
Franklin
Kincaid Reservoir Dam
Kincaid Reservoir
Valentine Lake Dam
Indian Creek Dam
Indian Creek Reservoir
Bayou Cocodrie Dam
Cocodrie Lake
Louisiana Noname 54 Dam
Lyle Lake Dam
Woodson Harvey Junior Lake Number One Dam
Chicot Lake
Chicot Lake Dam
Woodson Harvey Junior Lake Dams Two and Three
Doctor Charles Aswell Lake Dam
Cazans Lake Dam
Earl Fontenot Junior Pond Dam
Louisiana Noname 48 Dam
Louisiana Noname 49 Dam
Lake La Pointe Dam
Louisiana Noname 44 Dam
Louisiana Noname 45 Dam
Keystone Lock and Dam
Spanish Lake
Spanish Lake Dam
Sediment Pond Dam
Lake Fausse Pointe
Bayou Teche
Louisiana Noname 50 Dam
Vermilion Bay
West Cote Blanche Bay
N
W
E
S
10
0
10
20 Miles
LDEQ


Vermilion-Teche Basin
Land Use
Anderson Level 1 Classification
Agricultura
Barren
Forest
Rangeland
Urban or Built-up
Water
Wetland
N
10 0 10 20 Miles
The Louisiana Department of Environmental Quality (LDEQ) has made every reasonable effort to ensure quality and accuracy in producing this map or data set. Nevertheless, the user should be aware that the information on which it is based may have come from any of a variety of sources, which are of varying degrees of accuracy. Therefore LDEQ cannot guarantee the accuracy of this map or data set, and does not accept responsibility for the consequences of its use.
Planning, Assessment and Nonpoint
Map No. 200202010, January 2002
Base Map: 1:100k DLG
Projection: UTM Zone 15, NAD 27

LANDUSES

Land uses such as agriculture, urban, industry, and natural systems contribute to the loading of chemical, mineral, and biological elements to the waterways. Hydromodification affects the transport of water through the stream networks and often reduces the capacity of riparian zones to retain sediments on stream bank. Residential home sewage from faulty septic systems also contributes to the nutrient and organic loadings to the waterways. NPS pollutant loadings to the Teche within the watershed are the result of three main sources: agriculture, urban, and natural background. There is no silverculture and very little area used for oil production (extractive) in the watershed; however, the majority of the land is used for agriculture. Following up second is urban and/or rural residential. Discussed below are the suspect sources that contribute pathogens and oxygen-demanding substances to the Bayou Teche and its tributaries.

Landuse in the Bayou Teche Watershed

	Segment 060205		Segment 060301		Segment 060401		Segment 060501		Total	
Landuse	**Number of Acres**	**% of Area**	**Number of Acres**	**% of Area**	**Number of Acres**	**% of Area**	**Number of Acres**	**% of Area**	**Number of Acres**	**% of Area**
Urban	1,813	4.5%	186	35%	1,850	22%	4,303	10%	8,152	9%
Extractive	121	0.3%	47	9%	0	0%	127	0%	295	0%
Agriculture	25,824	64.1%	294	56%	6,497	77%	27,710	67%	60,325	67%
Forest Land	9,347	23.2%	0	0%	0	0%	0	0%	9,347	10%
Water	201	0.5%	0	0%	9	0%	357	1%	567	1%
Wetland	2,780	6.9%	0	0%	74	1%	8,675	21%	11,529	13%
Barren Lannd	161	0.4%	0	0%	0	0%	24	0%	185	0%
Total	**40,247**	**100%**	**527**	**100%**	**8,430**	**100%**	**41,196**	**100%**	**90,400**	**100%**

DISSOLVED OXYGEN AND NUTRIENT IMPLEMENTATION PLAN

Nutrients and nitrogen species such as ammonia are covered under the TMDL for DO and considered in the DO Implementation Plan. In other words, "when oxygen demanding substances are controlled and limited, nutrients are limited and controlled as well" (Sierra Club vs. Givens, 710 So.2d 249 (La. App. 1st Cir. 1997), writ denied, 705 So.2d 1106 (La.1998). Fecal coliform will be addressed separately, though in less detail than DO and nutrients, within this document.

POINT SOURCE DISCHARGES IN BAYOU TECHE

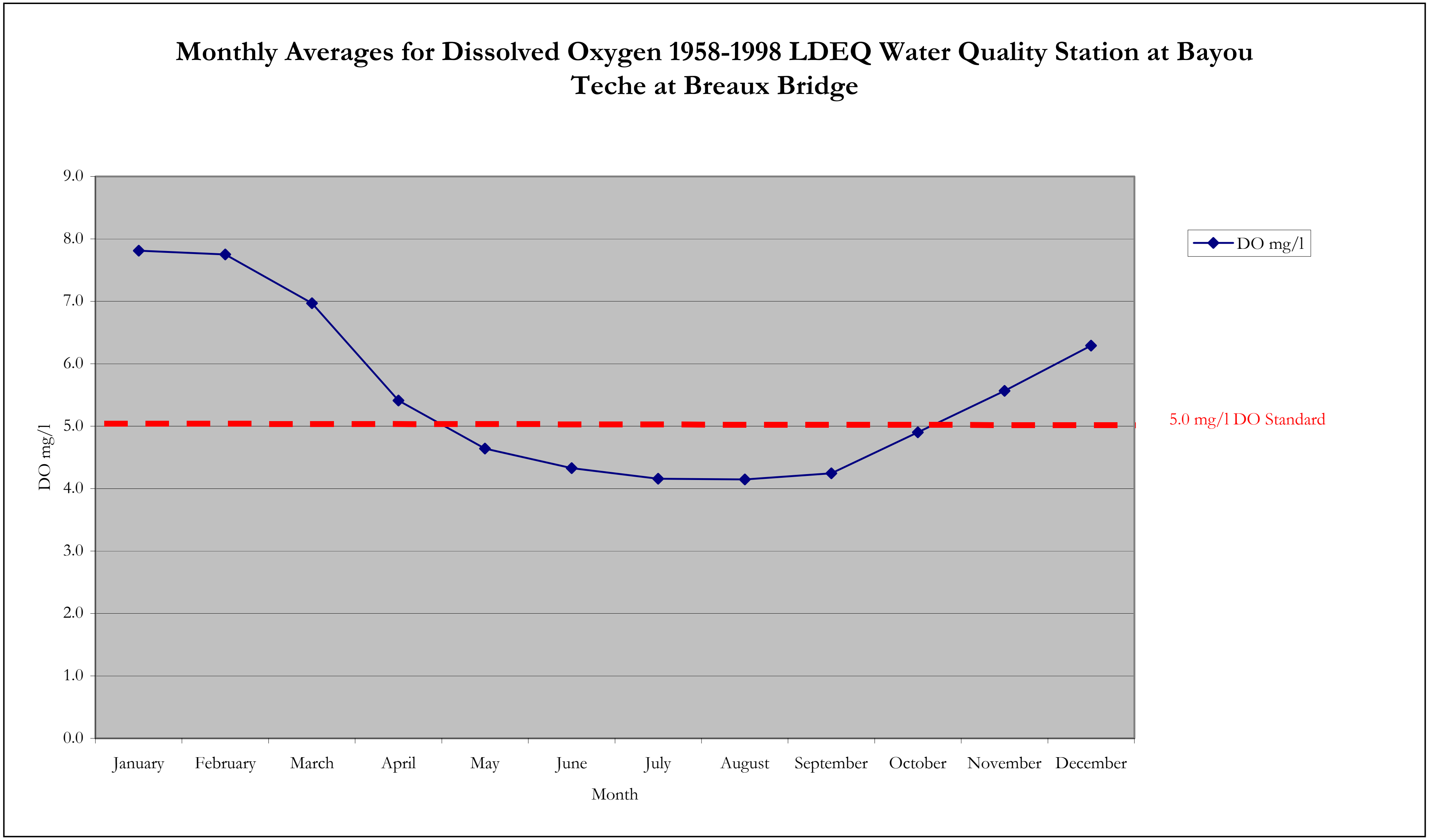
There are 110 known dischargers in the watershed, the majority of which are too small to have a significant impact on water quality in the watershed. Limits for the small discharges are generally set by state policy. Only 22 of the point sources are considered to have a potential impact on the Bayou Teche. Only 2 of the point sources will require more stringent effluent limitation to meet dissolved oxygen criteria. Reductions from point sources will be addressed in revisions to discharge permits.

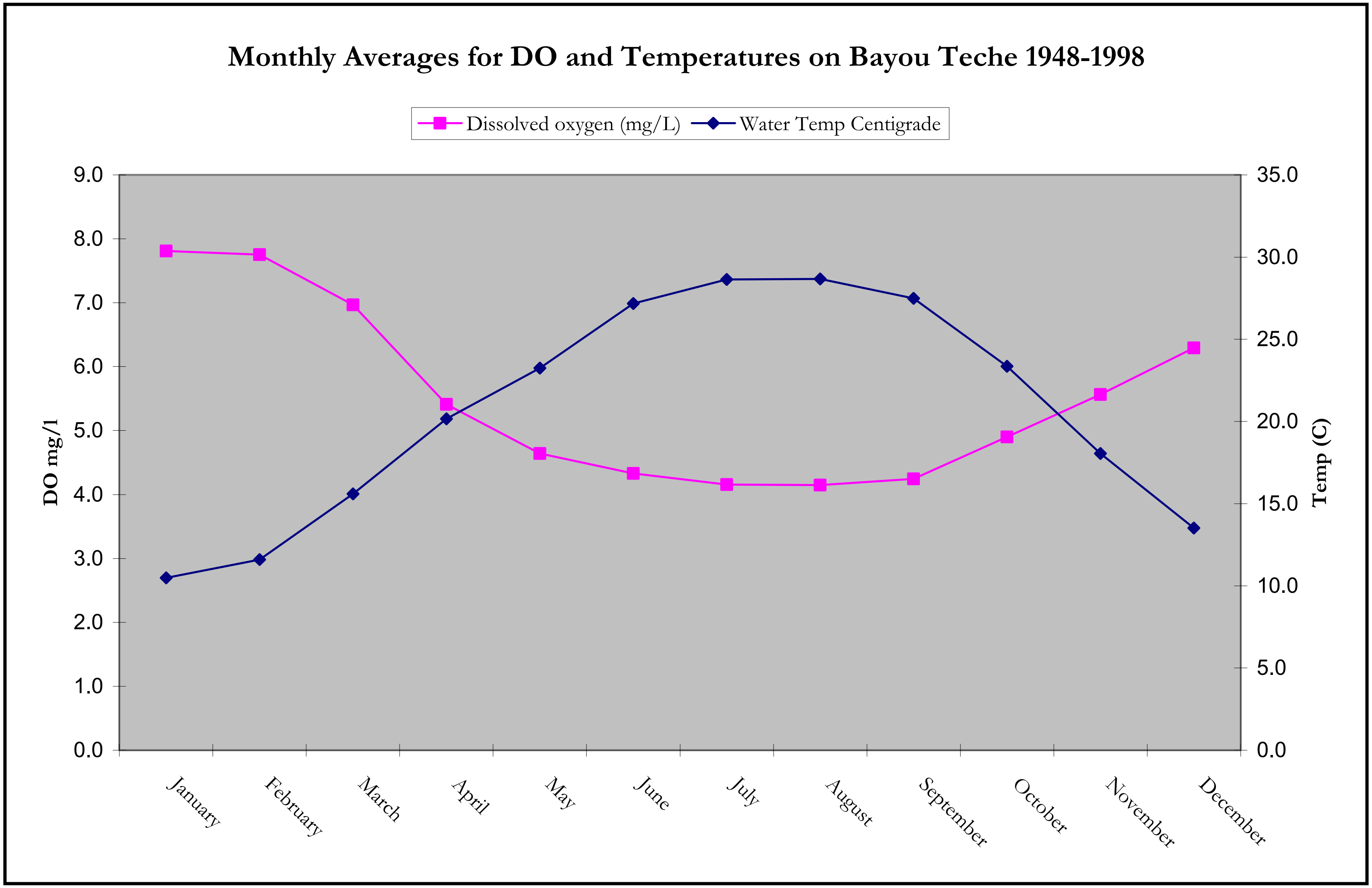
3.3 HISTORICAL DATA

Monthly Averages for Dissolved Oxygen, Oxygen Demanding Substance, and Fecal Coliform at Bayou Teche at Breaux Bridge

Month	Water Temp	Dissolved oxygen	NO2 Nitrate	Total Kjeldahl nitrogen	Total Phosphorus	Total organic carbon	Turbidity	Total suspended solids	Total dissolved solids	Fecal Coliform
	Centigrade	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	NTU	(mg/L)	(mg/L)	MPN/100 ML
January	10.5	7.8	0.2	0.8	0.2	9.2	61.9	48.2	143.1	1938.6
February	11.6	7.8	0.2	1.1	0.3	9.0	86.1	75.7	142.4	6854.0
March	15.6	7.0	0.2	0.9	0.3	9.7	69.7	49.6	147.7	1798.3
April	20.2	5.4	0.4	1.0	0.3	8.6	62.7	59.6	156.7	2987.5
May	23.2	4.6	0.6	1.0	0.2	7.9	82.5	69.9	184.3	3990.5
June	27.2	4.3	0.6	0.8	0.2	6.4	75.2	76.4	180.3	5614.2
July	28.6	4.2	0.7	0.8	0.2	8.2	53.6	43.9	195.8	5151.1
August	28.7	4.1	0.6	0.6	0.2	5.7	54.8	52.0	215.9	4720.0
September	27.5	4.2	0.6	0.7	0.2	7.4	36.3	31.9	199.8	819.0
October	23.4	4.9	0.7	0.7	0.2	6.1	34.3	30.7	187.0	3884.6
November	18.1	5.6	0.4	0.7	0.2	7.8	40.6	32.4	158.8	2450.6
December	13.5	6.3	0.4	0.8	0.2	10.1	63.9	52.7	141.1	4006.4
Criteria		3mg/l summer 5mg/l winter	Naturally occurring range [1]			NA	150 NTU	NA	260 mg/l	200 cfu primary 1000 cfu secondary

[1] The naturally occurring range of nitrogen-phosphorus ratios shall be maintained. Nutrient concentrations that produce aquatic growth to the extent that it creates a public nuisance or interferes with designated uses shall not be added to any surface waters. LAC 33:IX.1113.8


Monthly Averages for Dissolved Oxygen 1958-1998 LDEQ Water Quality Station at Bayou Teche at Breaux Bridge
DO mg/l
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
January
February
March
April
May
June
July
August
September
October
November
December
Month
DO mg/l
5.0 mg/l DO Standard


Monthly Averages for DO and Temperatures on Bayou Teche 1948-1998
Dissolved oxygen (mg/L)
Water Temp Centigrade
DO mg/1
Temp (C)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
January
February
March
April
May
June
July
August
September
October
November
December

NPS SOURCES OF OXYGEN DEMANDING SUBSTANCES

AGRICULTURE

The primary agricultural crops in the Bayou Teche consist of sugarcane, soybeans, and grazing pasture and there is some aquaculture in the form of crawfish farming during the winter months. Rain events suspend sediments, fertilizers, and pesticides and transport the agriculture runoff to the reaches of the bayou. Runoff from fields soon after tillage operations, fertilizer applications, and other field operations contains greater levels of sediments and pollutants. The cumulative effect of agricultural nonpoint pollutants results in potentially damaging concentrations of nitrogen, phosphorus, sediments, turbidity, and pesticide residue in the water bodies. Agriculture is assumed to comprise the majority of the NPS pollution simply because it constitutes 67% of the area in the four watersheds. The primary mechanism to reduce the amount of sediment and nutrients entering the waterbody is for the farmers to adopt Best Management Practices (BMPs) in order to meet TMDL objectives for the watershed. LDEQ and NRCS composed a list of seven types of BMPs that can be utilized to reduce agricultural NPS loading.

URBAN RUNOFF

Bayou Teche meanders through a number of townships rural communities. Recent water quality monitoring studies in urban and residential areas have shown that the highest pollutant loading and concentrations usually occur during rainfall events in the first runoff of rain, commonly referred to as the "first flush." In urbanizing an area, impervious surface area such as streets, parking lots, and rooftops, is increased. These smooth, impenetrable surfaces allow little or no detention or infiltration of stormwater. Pollutants that are present between rainfall events in the atmosphere prior to a storm and which accumulate on impervious surfaces are generally carried away in the first 1 inch of rainfall in moderate to heavy storms. Urban nonpoint source pollution is the result of precipitation washing the surfaces of urbanized areas. As precipitation falls on urban areas, it picks up contaminants from the air, parking lots, littered and dirtied streets and sidewalks; petroleum residues from automobiles, exhaust products, heavy metals and tar residuals from the roads; chemicals applied for fertilization, weed and insect control; and, sediments from construction sites. The dumping of chemicals such as used motor oil and antifreeze into storm sewers is another source of urban NPS pollution. Illegal hookups of storm drains to sanitary sewers can result in increased volumes of flow to waste water treatment plants causing more frequent overflows of sewerage into receiving waters.

While urbanization may enhance the use of property under a wide range of environmental conditions, urbanization typically results in changes to the physical, chemical, and biological characteristics of the watershed. As population density increases, there is a corresponding increase in pollutant loading generated from human activities. These pollutants typically enter surface waters via runoff without undergoing treatment.

Urbanization has a profound impact not only on water quality, but on the hydrologic characteristics of watersheds as well. In undeveloped natural drainage areas, the volume and rate of stormwater runoff from a particular rainfall event is primarily determined by the natural detention and infiltration characteristics of the land, and is related to topography, soil types, and vegetative cover. With less detention and infiltration due to impervious surfaces, runoff volume increases, as well as, the rate of stormwater runoff. Flooding and stream channel degradation in urbanizing watersheds has obvious adverse impacts upon public convenience, safety, and aesthetics, but there are some significant adverse impacts on water quality as well. When streams overflow their banks, there is an increased opportunity for pollutants including trash and debris to enter the flow of water. Erosion of the stream channel represents a significant source of sediment pollution, and the loss of vegetation along stream banks reduces the pollutant assimilation capacity of a stream.

HYDROMODIFICATION

Hydrologic modifications are defined as those activities, which are designed to affect natural stream flow. These types of modifications include bank stabilization, channel alignments, high-flow cutoff devices, instream construction, dredging, locks and dams, levees, spillways, and impoundments. Dredging, channel modifications, and impoundments are the most serious contributors to the nonpoint source pollution problem. Currently, all of these activities are being pursued in Louisiana waters, mainly for purposes of navigation and flood protection in coastal areas.

The Bayou Teche watershed receives approximately 57 inches of rainfall annually and has very low elevations and almost no slope. In order to prevent agricultural fields and homes from flooding, maintenance, dredging, and riparian zone removal has become a "fact of life." Many of the reaches along the bayou and its tributaries lack adequate riparian zones. Landowners and municipal authorities find it necessary to cut down trees and spray herbicides along the riparian zones in the watershed. The lack of riparian zones reduces the amount of shade over the waterway and the temperature of the water increase without the benefit of canopy cover from trees and bushes. Root matter from riparian zones also has the added benefit of retaining soils along the stream perimeter and prevents the banks from sheet and rill erosion. Dredging can cause scouring in some areas of the streambed and then deposit the sediments over larger areas. The process disturbs the benthic organisms by blanketing the streambed. Dredging will also suspend sediments in the water column, increasing turbidity and affecting water organisms.

HOME SEWERAGE

A significant portion of Louisiana's nonpoint source pollution can be attributed to sewerage runoff from homes, camps, and businesses that are not connected to municipal sewerage treatment facilities. It is estimated that 1,323,600 people in Louisiana treat and dispose of their sewerage with individual waste disposal systems, and that over 50% of these systems are malfunctioning because of incompatible soil types or lack of maintenance. These failing systems are a major cause for water quality degradation in Louisiana's scenic streams and fresh water aquifers. Septic tank systems normally consist of two components, a treatment unit and a disposal unit. The septic tank and soil absorption system is the most common individual waste disposal system used in Louisiana. The purpose of the septic tank is to condition household wastes so that the discharge will readily percolate into the soil. This conditioning is done in a septic tank by the removal of solids by settling and also by decomposition of the soluble organics. The soil then provides additional treatment by the removal of bacteria, organics, and nutrients. One of the main problems with using conventional septic tank soil absorption systems in Louisiana is that 87 percent of the soil associations in Louisiana are considered inadequate for conventional septic tank systems as determined from the Soil Limitation Ratings for Sanitary Facilities (LDOTD, 1981). Another major component to the pollution caused by septic tank systems is inadequate enforcement of the State Sanitary Code. A properly designed septic tank consists of a buried, watertight, multiple compartment tank, usually of concrete material, equipped with inlet and outlet devices and scum control baffles.

3.4 PHYSICAL, CHEMICAL, AND BIOLOGICAL CAUSES FOR OXYGEN DEPLETION

SEDIMENT OXYGEN DEMAND AND REAERATION

The slope of the Bayou Teche is very gradual and the potential for reaeration is low. The bayou is slow moving and depositional in nature, resulting in continued sedimentation within the streambed. The watershed rests on an alluvial plain were soils are composed of silty loams and clays. Organic matter attaches to the to the clay and silts and creates an oxygen demand as the particles decompose within the waterway. After time, this process results in a layer of muck along the streambed. This layer of muck creates what is commonly referred to as sediment oxygen demand (SOD). Agriculture is the largest contributor to the accumulation of sediments and nutrients to the waterway. Rain events suspend exposed soils and fertilizers, transport them overland, and deposit them in the bayou. Nutrients encourage the growth of aquatic plants and nitrifying bacteria. Respiration consumes DO and the decomposition of the organisms contributes to SOD and/or eutrophication. Sediment oxygen demand is the amount of oxygen consumed by the bacteria as they attack the organic material that has settled or been captured to form a sediment or sludge deposit. Composed largely of particles of organics attached to sediments, feces, dead algae, and decaying plant matter, the accumulated sediments can dominate oxygen dynamics. Both winter and summer fish-kills in natural systems, caused by oxygen depletion, can be attributed to oxygen consumption by the sediments.

CARBONACEOUS BIOCHEMICAL OXYGEN DEMAND

The waterways contain particulate or dissolved organic materials that can serve as food for heterotrophic bacterial communities, which in turn consume large amounts of oxygen. The potential impact of these dissolved organics on the water's oxygen supply is estimated by measuring the water's carbonaceous biochemical oxygen demand (CBOD). The CBOD of a sample is measured by observing the oxygen drop in a sealed bottle over a fixed number of days (usually five). The number of days used in the test is indicated by a suffix, i.e., CBOD5. A high CBOD5 (>15 mg/l) implies that a lot of bacterial activity will occur in the water throughout the day and night as the bacteria attack the suspended or dissolved organics.

NITROGENOUS BIOCHEMICAL OXYGEN DEMAND

The nitrogenous biochemical oxygen demand (NBOD) is a major cause of oxygen loss in aquatic systems. NBOD is a measure of the amount of oxygen that is consumed by the nitrifying bacteria as they convert total ammonia nitrogen (TAN) to nitrate. Approximately 4.57 milligrams of oxygen are consumed for each milligram of TAN converted to nitrate nitrogen. TAN is directly excreted into the water by a wide variety of aquatic organisms and is very difficult to remove without bacterial activity. Unless the water is rapidly flushed, the water's NBOD must be satisfied within the system. TAN is also produced as a by-product of the decay of sediments and sludges as the bacteria break down proteins and amino acids to form ammonia.

HIGH TEMPERATURES AND LOW FLOW

Biochemical reactions, in general, follow the van't Hoff rule of a doubling of the reaction rate for a 10oC increase in temperature over a restricted temperature range. Therefore, temperature is strongly inversely proportional to dissolved oxygen levels. July and August are the hottest months in Louisiana, while October and November are the months with lowest stream flows. Dissolved oxygen and runoff are moderately directly proportional. The TMDL analysis concluded that critical conditions for stream DO concentrations were those of negligible nonpoint run-off and low stream flow combined with high stream temperature. When the rainfall and stream flow are high, turbulence is higher due to higher flow and the temperature is lowered due to rainfall run-off. Reaeration rates are much higher when water temperatures are cooler and BOD decay rates are much lower. For these reasons, periods of high loadings are periods of higher reaeration and DO but not necessarily periods of high BOD decay. LDEQ interprets this phenomenon in its TMDL modeling by assuming that the annual nonpoint loading, rather than loading for any particular day, is responsible for accumulated benthic blanket in the stream, which is expressed as SOD or re-suspended BOD. This accumulated loading (SOD) has its greatest impact on the stream during periods of higher temperature and lower flow. NPS pollutant loadings, primarily agriculture, are the major source of this SOD in the Bayou Teche watershed.

Best Management Practices Implementation Plan: Achieving Goals in Watershed

INTRODUCTION

A number of sources contribute to the NPS load of oxygen demanding substances. Approximately 67% of the landuses in the watershed are agriculture so the majority of the BMP implantation effort will be directed towards agricultural practices. Urban areas also contribute a sizeable amount of NPS pollution although urban areas only constitute 3.5% of the land area. This section of the implementation plan also discusses BMPs for urban areas. Home sewage from malfunctioning septic tanks of rural residential sites contributes considerable amounts of nutrients to the overall NPS loading and so home sewerage will be addressed in this section as well. Hydromodification can be a factor to stream bank erosion and create areas of deposition and scouring. Plan to reduce the detrimental effects of hydromodification will be presented below as well.

AGRICULTURE BEST MANAGEMENT PRACTICES

Agriculture is a major industry in Louisiana and will continue to be important to the state's economy. Conventional crop production involves the removal of protective ground cover and the use of nutrients and pesticides to maintain high production levels. The resulting nonpoint source pollutants which may end up in receiving water bodies include: sediment, pesticides, nutrients, and oxygen demanding organic matter. Animal production results in the generation of large quantities of organic material and nutrients, both of which are potentially nonpoint source pollutants. Agriculture constitutes 67% of the landuses in the Bayou Teche with the primary crops including: rice, sugarcane, soybean, pasture, and some crawfish farming during the winter months. The majority of our BMP efforts will be directed towards Agriculture since it is the largest contributor of NPS pollutant loading in the watershed.

VARIOUS BMPS TO REDUCE AGRICULTURAL NPS RUNOFF

Farmers can choose from a wide variety of BMPs approved and tested by NRCS. Each BMP is a culmination of years of research and demonstrations by agriculture research scientist, soil engineers, and farmers. The primary agricultural crops in the Bayou Teche watershed consist of rice, sugarcane, soybeans, and grazing pasture and there is some aquaculture in the form of crawfish farming during the winter months. Many practices are available to the farmer for each of the various crops. Some of the BMPs include reduction of tillage operations, residue management, filter strips, riparian buffer zones, fertilizer management, pesticide management, and other techeniques.

The BMPs are published in the NRCS's Field Office Techenical Guide, which is routinely updated and expanded. The BMPs are also available on LSU's AgCenter web page at: www.lsuagcenter.com. In addition to the government funded BMP research, an abundance of scientific literature is available regarding conservation tillage, filter strips, riparian buffer zones, residue management, and many other management practices designed to reduce the amount of runoff leaving the fields and into the waterways.

The solutions to controlling runoff will require the joint efforts of agriculture producers, landowners, government, private citizens and private organizations working together. The Louisiana Cooperative Extension Service (LCES) and Louisiana State University (LSU) AgCenter conducted a commodity specific BMP review. These reviews were conducted through a multi-agency/organization partnership made up of research and extension scientist, the Louisiana Farm Bureau (LFBF), the Natural Resources Conservation Service (NRCS), the LDEQ, USDA-Agriculture Research Service (ARS), and agriculture producers.

CURRENT BMPS IN BAYOU TECHE

It is currently unknown what BMPs are in place in the watershed.

THE MASTER FARMER PROGRAM

LSU AgCenter is promoting the Master Farmer Program to help farmers address environmental stewardship through voluntary, effective, and economically achievable BMPs. The program will be implemented through a multi-agency/organization partnership including the Louisiana Farm Bureau (LFBF), the Natural Resources Conservation Service (NRCS), the Louisiana Cooperative Extension Service (LCES), USDA-Agriculture Research Service (ARS), LDEQ, and agricultural producers.

The Master Farmer Program will have three components: environmental stewardship, agricultural production, and farm management. The environmental stewardship component will have three phases. Phase I will focus on the environmental education and crop specific BMPs and their implementation. Phase II of the environmental component will include in-the-field viewing of implemented BMPs on "Model Farms." Farmers will be able to see farms that document BMP effectiveness in reducing sediment runoff. Phase III will involve the development and implementation of farm-specific, comprehensive conservation plans by the participants. A member must participate in all three phases in order to gain program status.

This program can help to initiate and distribute the use of BMPs throughout the Teche watershed. The members will set an example for the rest of the agricultural community. They will work closely with scientists and other Master Farmers to identify potential problems areas in the watershed. They will receive information on new and innovative ways to reduce soil and nutrient loss from their fields. They will be kept abreast of the water quality monitoring occurring in the watershed and alerted of any degradation or improvements. The Master Farmer Program will allow stakeholders and agencies to observe the acceptance of BMPs throughout the watershed and they will help LDEQ observers track the implementation of soil management plans.

BMP IMPLEMENTATION: COST SHARE

§319(H) FUNDING OPTIONS

A number of Federal and State funding sources exist for BMP implementation and land conservation. The LDEQ Non-Point Source group provides USEPA §319(h) funding to assist in implementation of BMPs to address water quality problems on reaches listed on the §303(d) list or which are located within Category I Watersheds as identified under the Unified Watershed Assessment of the Clean Water Action Plan. USEPA §319(h) funds were utilized to sponsor the cost sharing and monitoring projects discussed above. These monies are available to all private, for profit and nonprofit organizations that are authenticated legal entities, or governmental jurisdictions including: cities, counties, tribal entities, Federal agencies, or agencies of the State. Proposals are submitted by applicants through a Request for Proposal (RFP) process and require a non-federal match of 40% of the total project cost consisting of funds and/or in-kind services. Further information on funding from the Clean Water Act §319 (h) can be found at the LDEQ web site at: www.deq.state.la.us.

OTHER FEDERAL AND STATE FUNDS

The U.S. Department of Agriculture (USDA) offers landowners financial, techenical, and educational assistance to implement conservation practices on privately owned land to reduce soil erosion, improve water quality, and enhance crop land, forest land, wetlands, grazing lands and wildlife habitat. One of these programs is the Conservation Reserve Program (CRP). It is designed to encourage farmers to convert highly erosive cropland to vegetative cover, such as native grasses, wildlife plantings, trees, filter strips, or riparian buffers. Farmers receive annual rental payment for the term of the multi-year contract. The Conservation Reserve Enhancement Program (CREP) combines the resources of the CRP program with that of the State government. This program focuses on NPS pollution and water and habitat restoration. The Environmental Quality Incentives Program (EQUIP) is another source of funding available to the farmers for conservation practices. These are a few of the State and Federal funding sources available to agricultural landowners that will help with the cost of reducing NPS run-off from their fields.

LDEQ 319 MONITORING SCHEDULE

As LDEQ continues to monitor the water bodies across the state on the 5-year basin cyclic program, annual progress made in BMP implementation will be documented and reported to EPA, the NPS Interagency Committee and the general public through LDEQ's website. The first cycle of water quality monitoring will utilize the data collected to develop the TMDL and devise the watershed restoration action strategy. The second cycle will provide a baseline data for TMDL Implementation Plan and third cycle will determine whether the Implementation Plan has been effective in reducing nonpoint source pollutants and improving water quality within the water body. If this third cycle of water quality monitoring does not indicate a significant improvement in the implementation of agricultural best management practices within the watersheds on the 1998 303(d) list, then LDEQ and the cooperating federal and state agencies will determine whether back-up authorities are necessary to achieve the BMP implementation required to reduce nonpoint sources of pollution and improve water quality.

URBAN BEST MANAGEMENT PRACTICES

INTRODUCTION

Phase I and Phase II of Urban Storm Water Regulations will be enforceable in the Teche watershed since there are two urban areas in the watershed with populations greater than 50,000. Water quality goals in urban areas of the watershed are virtually the same as in other types of land-use categories, but they are often more difficult to achieve. The types of pollutants associated with the low dissolved oxygen concentration were sediments, nutrients, and organic enrichment. These pollutants come from construction sites, lawns and golf courses, and industrial parks. Oil and grease and metals also continue to be included in the array of pollutants associated with urban nonpoint source pollution. Oil and grease comes from streets and parking lots and also from people who change the oil in the family automobile and dispose of the used oil down the storm drain. In order to address the long-term water quality goals of restoring the designated uses for urban stream, the types of pollutants defined will need to be reduced.

CURRENT BMPS IN URBAN AREAS OF THE TECHE WATERSHED

Currently, there are no educational programs or any systematic reduction program for Urban NPS pollution in place in the Bayou Teche watershed.

VARIOUS BMPS TO REDUCE URBAN NPS RUNOFF

Citizens and city planners have a wide variety of urban BMPs to choose from to address the many different sources of NPS pollution in urban settings. A list of Stormwater BMPs are available with in this document that are LDEQ approved methods for construction sites, parking lots and other impervious surfaces, industrial parks, residential homes and lawns, and automobile service centers.

STORM DRAIN STENCILING AND MARKER PROGRAM

Louisiana's NPS Program has had a storm drain stenciling program since 1991, which has proven to be very popular and rather extensively implemented in cities and smaller communities across the state. In 1998, LDEQ ordered storm drain markers, which are basically a plastic decal that can be glued to the storm drain. It has the message, "Dump No Waste..Drains to Stream." Citizens are reminded that their runoff wastes are discharge directly into the rivers, streams, and bayous.

OIL AND GREASE

Oil and grease from parking lots and streets can be controlled with infiltration trenches, grassed swales or wetlands and filters in storm drains. Storm drain stenciling or marking programs can be one method to reduce the amount of used oil down storm drains. These types of programs combined with a better understanding of how and where used oil and antifreeze should be disposed of can reduce the amount of these chemicals in our urban streams.

URBAN EDUCATIONAL MATERIALS

Educational materials such as brochures, fact cards and pamphlets are an important component to any watershed or statewide educational program. People need to clearly understand what the water quality issue is and how their activities contribute to the pollution problem. The educational materials that LDEQ has designed have been very popular with both adults and children and have been widely distributed through many workshops, schools, conferences, and other public events across the state. The messages are simple, but clearly stated so that each individual can understand which type of actions that they can take to reduce nonpoint source pollution from their home, lawn, or neighborhood. Examples of the message on some of these materials have been included here and copies can be obtained by contacting the Louisiana Department of Environmental Quality (LDEQ).

URBAN EDUCATIONAL VIDEO

In 1999, LDEQ decided to develop an educational video on urban nonpoint source pollution that could be distributed to the townships in the watershed. The objective of the video is to highlight actions that some of the cities and communities across the state have taken to address their urban nonpoint source pollution. In order for these management measures to be sufficiently implemented to reduce and control urban nonpoint source pollutants, federal, state and local authorities will need to be utilized.

FUTURE OBJECTIVES AND MILESTONES

The future objectives and milestones for the urban nonpoint source program are to continue to educate city officials, engineers, planners, developers, and the general public about urban nonpoint source pollution. This educational program will rely on materials and information already developed, but will continue to build on new information that has been successfully utilized in other states and cities. Information on home lawn chemicals, urban forestry, sustainable and cluster development, urban wetland detention areas, and many other techenologies will continue to be provided to the cities across the state. In addition to providing educational materials, LDEQ will work with other state and local governments to form local nonpoint source working groups or coalitions where the specific nonpoint source problems can be identified and best management practices (BMPs) implemented to reduce and control them.

COOPERATING ENTITIES

The Coastal Management Division of Dept. of Natural Resources (CMD-DNR) has worked with LDEQ on nonpoint source programs for coastal communities across Louisiana. They have developed educational brochures, displays and slide presentations on urban nonpoint source management measures. They have utilized these materials in workshops, meetings, conferences, and local nonpoint source coalitions in many of the coastal areas across south Louisiana. As the Coastal Nonpoint Pollution Control Program was developed, they worked closely with the local communities, LDEQ, EPA and NOAA on how this program would be structured and how their coastal use permit could be utilized as one mechanism to implement urban best management practices. As the state moves into the implementation phase of that program, CMD-DNR will be working even more closely with coastal communities, LDEQ and other cooperating entities on reducing and controlling coastal nonpoint source pollution problems.

The CMD will assist the LDEQ with implementation of the program activities described in letters a-g of the programmatic activities section. The CMD also plans to work with cooperating agencies to develop and erosion patrol program for citizens and volunteers, a "Subdivision Evaluation Guide" for permit analysts and developers, an extensive information clearinghouse website, and educational materials.

The CMD's Coastal Use Permit (CUP) Program issues permits for activities that directly and significantly affect coastal waters. CMD will review the permitting process for the inclusion of nonpoint source controls into the CUP Program and will assist parish Local Coastal Programs in developing and incorporating nonpoint controls into their coastal management programs.

LDEQ will continue to be responsible for coordinating the partners and working with all interested entities that can assist in meeting both the programmatic and water quality short term and the long-term goals. This coordination includes accepting proposals from federal, state, local, private entities or individuals that would like to design and/or implement and urban educational activity, such as a demonstration project, an educational tool or outreach program. LDEQ will also exercise oversight and management responsibilities for all projects that are funded with Section 319 funds, working with the cooperators on their implementation. LDEQ will also track the progress and results of all projects and report on them to EPA and other participants in the state's NPS Management Program. LDEQ will evaluate each project to ensure that its programmatic and water quality goals and objectives were met.

ACHIEVING GOALS

Addressing urban nonpoint source pollution is difficult since there is not a federal or state infrastructure for urban areas like there is for agricultural and forested areas of the state. However, there are a many things that can be done to address urban nonpoint pollution issues. These activities include: storm drain stenciling and marking programs that can be disseminated into the local community; urban nonpoint source educational materials that can be distributed through parish and city offices; an urban educational video that highlights the pollution problems and pollution control methods that can be implemented to reduce these pollutants; an urban educational program developed and implemented through statewide organizations such as the Louisiana Cooperative Extension Service, the Office of Soil and Water Conservation, Louisiana Department of Natural Resources/Coastal Management Division, Natural Resource Conservation Service, Resource Conservation and Development Districts, Urban Forestry Council, Municipal Associations, etc. develop and/or implement local ordinances that require implementation of urban best management practices; and encourage and track the use of checklists such as Pesticide Application Checklist, Auto Repair Checklist, and the Construction Site checklist as a method to track BMP implementation.

LOUISIANA COOPERATIVE EXTENSION SERVICE

The Louisiana Cooperative Extension Service has continued to work with LDEQ on nonpoint source educational programs in urban areas, including lawn care education programs, citizen monitoring programs, and teacher training programs on water quality issues. They have participated in urban nonpoint source coalition meetings in several areas within the state and were also involved in discussion and dialogue of how the educational components of the Coastal Nonpoint Pollution Control Program could be implemented. Their involvement in pollution prevention plans and programs has assisted the state in obtaining conditional approval on the state's CNPCP. As the state obtains full approval of that program and moves into the implementation phase, the LCES will be involved in many of its educational components.

URBAN PROGRAM TRACKING AND EVALUATION

In order for progress to be monitored and evaluated, it is important to track the level and also the pace of implementation of the goals and objectives outlined within this document. LDEQ reports on progress made in all of the areas of the NPS Management Program to the NPS Interagency Committee. This is done through quarterly newsletters and meetings and also through LDEQ's web-site. Progress is reported on all of the goals and milestones outlined within the NPS Management Plan to EPA Region on an annual basis. Semi-annual reports highlight project activities and progress made in specific areas of the program.

Hydromodification

INTRODUCTION

Section 404 of the Federal Water Pollution Control Act (FWPCA) establishes a permit program, administered by the Secretary of the Army, acting through the Chief of Engineers, to regulate the discharge of dredged material and those pollutants that comprise fill material into waters of the United States. Section 404(c) gives the Administrator of the EPA further authority, subject to certain procedures, to restrict or prohibit the discharge of any dredged or fill material that may cause an u nacceptable adverse effect on municipal water supplies, shellfish beds, and fishery (including spawning and breeding areas), wildlife, or recreational areas.

Dredging typically increases the turbidity in the water body by disturbing the bottom sediments, which have accumulated over an extended period of time. Dredging causes a resuspension, redissolution, or leaching of these materials. The concern that arises is that toxic substances or heavy metals may be reintroduced to the water column where they can adversely affect plant and animal life and other beneficial uses of the water body. Within Louisiana, the re-suspension of the benthic sediments often results in the organic material attached or stored with the sediments also being suspended within the water column, adding to the oxygen depletion of the bayou or stream.

There are a number of methods used to perform channel modifications. These include clearing and snagging, modifications of existing channels, and new channel excavation. Clearing and snagging are used to remove obstructions and restore the hydraulic capacity of the stream. Channel excavation is used to increase the hydraulic conveyance. This can be done by widening and deepening the channel or by eliminating meanders.

The types of water quality problems associated with these activities include vegetative and soil cover disturbance during construction, increased scour due to increased water velocities, and increased water temperature if overhanging vegetation is removed. Further increasing velocities increase the reach over which organic pollutants can exert an oxygen demand.

A brief summary of the types of pollutants which are associated with hydrologic modifications and types of water quality problems associated with them, are discussed in the following section.

Sediment - The predominant pollutant generated by impoundment construction and dredging is sediment. This material can settle over large areas, blanketing bottom life, or becoming resuspended in the water column, increasing turbidity and affecting water organisms. Secondarily, many chemicals such as pesticides, certain organic compounds, and metals will sorb to sediment particles and be redistributed as the sediment is transported. As sediments resuspend, these materials can reenter the water column and act as an uncontrolled source of pollutants. This problem can be a very severe one (refer to page 82 for more description of the affect of sediment on aquatic ecosystem).

The tendency of impoundments to trap sediments is a major benefit to downstream water quality and one of the motivations behind small soil conservation structures. However, the accumulation within the reservoir of the chemicals sorbed to the sediment particles can cause bioaccumulation of these chemicals as they pass up the food chain to fish, shellfish, birds, and eventually to humans.

Nutrients - As mentioned above, increased sediment loads due to hydrologic modifications may also cause a companion nutrient load. Further, because of greater flood protection in the area where an impoundment has been constructed, agricultural activities may increase, thus promoting the use of fertilizers and pesticides in the watershed and contributing to the accumulation problem.

Hydromodification in urban areas may increase nutrient loads from fertilizer use from lawns and gardens.

Pesticides and Heavy Metals - These substances are also sediment related. They accumulate in an impounded water body and are regenerated through dredging activities or high flow scour. Fish and shellfish industries can be adversely affected by dredging activities if the sediments have accumulated these substances.

Organic Pollutants - Simple organic compounds are generally biochemically oxidizable and cause a resulting loss in the dissolved oxygen in a water body. Whereas concentrations of organic pollutants may not be affected by hydrologic modifications, the ability of the water body to withstand the oxygen demand may be. This can result because of altered reaeration rates, water temperatures, velocities, dilution, or the addition of inhibitory substances. Furthermore, decreased dissolved oxygen concentrations may occur in a river with a series of run of the river dams because of stagnation of the water and the release of poor quality water from one impoundment to the next.

More complex organic pollutants may not be biochemically degradable, and so may not exert an oxygen demand. However, they may have toxic or inhibitory effects similar to those of pesticides or heavy metals. Once added to a body of water, hydrologic activities discussed in this chapter may periodically resuspend these materials and increase the chances of contact with organisms.

Thermal Problems - The restructuring of a channel's configuration may affect the ambient water temperature by altering average depth, hydraulic energy, or by removing protective tree canopy. This, in turn, may affect dissolved oxygen saturation, kinetic coefficients, or solubility of certain substances. Further releases of cold water from deep reservoirs into shallower, warmer streams may affect fish and other organisms for which a proper temperature range is critical.

ACHIEVING GOALS

When streambank vegetation, such as trees are removed from the edge of the stream, it can have several affects on the water quality. If the trees provided shading to the stream, then their removal can result in increased stream temperature and decreased dissolved oxygen concentrations. If the trees were providing organic input to the stream by leaf material and woody debris, then removing the trees can result in a decreased food source for macro-invertebrates and woody debris for fish habitat. This woody debris is an important component of fish habitat in bayous and streams of Louisiana, since bayous often do not have pools and riffles in them. Pools and riffles develop around the woody debris that falls into the stream or bayou and provide good habitat for fish and macro-invertebrates. Removing trees from the streambank can also result in increased soil erosion from steep banks if proper stabilization methods are not utilized. This increased erosion can result in higher concentrations of suspended solids in the stream as sediment is washed from the bank during storm water events. The increased sediment in the stream can lead to turbidity or murky water that has the potential to affect the designated use for fish and wildlife propagation.

When a water body is straightened, the hydrologic characteristics are altered which can affect its ability to re-aerate itself. In the Mermentau River Basin, hydromodification has created areas called "stretch lakes" in many of its bayous. These long, wide segments of the bayou begin to function more like a lake than a flowing stream. Bayous are naturally slow-moving water bodies that transport large amounts of sediment and organic material. As the bayou is channelized and a stretch lake is formed, the pollutants settle out and are deposited on the bottom similar to a detention basin. Once these stretch lakes are formed, it is very difficult to flush the pollutants out of the system because the flow has been reduced to such an extent that the pollutants are no longer transported but are deposited in this wide, deep portion of the bayou. These segments of the bayou typically exhibit almost no flow and have very low dissolved oxygen concentrations.

Therefore through hydromodifcation, often both the streambank and the stream channel are altered. These alterations affect the dynamics of the stream or bayou in many ways, primarily changing the energy of the stream, which affects its flow and its ability to transport pollutants and re-oxygenate itself. Urban streams are often channelized so that they can transport the water more quickly, thereby reducing flooding. Through this process the energy of the stream typically increases and transports the water and the associated pollutant load downstream where it is deposited in a lake, estuary or wetland. If the stream is converted to a channel that has a homogenous substrate, this can also affect fishery populations by decreasing habitat diversity. The combined effect of stream channel alteration and removal of riparian vegetation along the streambank often lead to lower dissolved oxygen concentration and reduced species diversity of fish and macro-invertebrates.

The water quality goals related to hydromodification are to reduce the impact that physical alteration of the water body has on the temperature and the dissolved oxygen. These two water quality parameters are utilized to determine if the fish and wildlife propagation use is being met or protected. The programmatic goal is to either reduce the frequency and extensiveness of hydromodification in Louisiana's water bodies or to implement the types of best management practices included within this document in order to reduce the impacts that hydromodification has on the fish and wildlife habitat. If steps are taken to implement best management practices (BMPs) on agricultural and forested lands and at construction sites, then less sediment should get into the water. If urban planning for new developments include detention basins and vegetated wetlands to trap sediments and organic material, then fewer pollutants will be delivered to the water body. If the water body has a lower concentration of sediment, nutrients, and organic matter to transport, then it should be able to retain its carrying capacity for water more efficiently. This should result in more effective drainage and less frequent dredging. Less frequent dredging should result in improved aquatic habitat for fish and macro-invertebrate populations and improve the designated use for fish and wildlife propagation.

EXPLAIN PROGRAMMATIC ACTIVITIES TO REACH THOSE GOALS

The programmatic activities that will be implemented to reach the water quality goals include increased implementation of best management practices for agriculture, forestry and urban storm water runoff. Through the reduction of sediment and other pollutants associated with these three land-use categories, the need for channelization of streams, bayous and rivers should be reduced. There also needs to be an extensive educational program for police juries, city engineers and parish drainage boards on innovative ways to manage streams and drainage systems at the local level. Most of them spend a great deal of their time planning projects and hearing complaints to alleviate drainage problems. The most effective way to address these problems is through a watershed focus instead of working on the water body in a piece meal fashion that never examines it as a total system. Through recent work in Tangipahoa Parish, the Louisiana Department of Environmental Quality (LDEQ) worked with the Parish Drainage District and University of Southeastern Louisiana on a streambank vegetation management project. This project has resulted in a manual that instructs parish drainage boards and police juries on the steps that can be taken to manage vegetation with less pesticides and disturbance of the steambank. This manual will be made available to each of the 64 parishes across the state as one educational tool to illustrate the importance of streambanks in maintaining and improving water quality.

FUTURE OBJECTIVES AND MILESTONES

A new handbook on Stream Corridor Restoration that was compiled through a cooperative effort of fifteen federal agencies contains step-by-step guidelines on managing streams from a watershed approach. For a short-term goal, the NPS Unit will work with USDA on a series of workshops where these principles are explained and copies of the workbook are provided to the local governments. These workshops can be held in areas where urban development or agricultural production is placing additional stress on the bayous and streams (i.e. East Baton Rouge Parish, St. Tammany Parish, etc.). The Natural Resource Conservation Service is trained to implement many of the principles within this workbook. LDEQ will work with NRCS to disseminate these watershed restoration concepts in areas of the state where hydromodification has affected the physical characteristics of the stream. Educational workshops, demonstration projects that illustrate the streambank restoration techeniques and techenical reference manuals can all be utilized as methods to reduce the impact that hydromodification has on streams and bayous in Louisiana.

- Work with USDA on hosting a workshop on Stream Corridor Restoration (short-term);
- Develop partnerships with local drainage boards, police juries and conservation districts to implement these restoration strategies within watersheds that have been impaired by streambank and channel alteration (short-term);
- Implement a project where these restoration strategies are utilized as a method to improve aquatic habitat (short-term);
- Host field tours to illustrate the principles utilized at the project site and educate parish and city officials on the benefits of the techeniques (short-term);
- Develop an educational video and brochure to accompany the workbook so that other districts, parish and city officials can learn to utilize these restoration strategies (short-term);
- Track the implementation rate of these methods through Local Soil and Water Conservation Districts, NRCS and other local entities (short-term);
- Measure water quality improvement through improved habitat, biological communities, and chemistry of the water in areas where the restoration techeniques have been implemented (short-term);
- Report on progress made in this programmatic area to EPA on an annual basis (short-term);
- Determine if additional steps are necessary to reduce the water quality impact that hydromodification has on water bodies within Louisiana and work with the Corp of Engineers, the Local drainage Boards and the Police Juries to implement these steps within each of the drainage improvement projects (long-term);
- Track whether these steps have been successful in improving water quality and reducing nonpoint source pollution that results from hydromodification projects (long-term).
- Utilize the federal, state and local regulations, laws and ordinances that are applicable to requiring that best management practices be incorporated into 404 and 401 projects, in order to reduce the impact that hydromodification has on the state's water bodies (long-term);
- The LDNR/CMD will coordinate it program with the LDEQ program, and will track the progress and report to NOAA (short-term);
- LDEQ and LDNR/CMD will coordinate education and instructional efforts through the Local Coastal Program, when this approach is most functional (short-term).

The goals of the Statewide Hydromodification Education Program are to incorporate nonpoint source water quality goals and objectives into state, federal and local programs that manage stream channels and streambanks. Louisiana Department of Environmental Quality has committed to the previous goals and objectives in order to improve the quality of the streambank and aquatic habitats along the state's water bodies. Since all of the waterbodies on the state's 1998 303(d) list will have TMDLs developed within the next 10 years, the hydromodification issues will be included within the watershed restoration action strategies and implementation plans. These steps are consistent with the goals and objectives of this section of the NPS Management Program and are expected to result in water quality improvement within the next 10-15 years.

COOPERATING ENTITIES

NATURAL RESOURCE CONSERVATION SERVICE

The Natural Resource Conservation Service often provides techenical assistance and support for local drainage projects. These requests often come for the local drainage district or police jury that is responsible for maintaining drainage at the parish level. There is a long history of in both rural and urban watersheds for bayous and streams to be viewed primarily as avenues for draining farmlands and subdivisions. In order for these practices to change, the NRCS and all of the cooperating agencies at the federal, state and local level will need to work toward a more environmentally sensitive method of ensuring adequate drainage. NRCS has valuable techenical expertise in both the land management and the water quantity issues that are the basis of the hydrology issue. They will continue to be an important partner in any changes made in methods utilized for local drainage projects.

SOIL AND WATER CONSERVATION DISTRICTS

The Local Soil and Water Conservation Districts are often also included with NRCS in planning the local drainage project at the parish or district level. Members of the local board for Soil and Water Conservation Districts are often farmers and landowners that are in support of the drainage projects. In order for streambank restoration or protection projects to be implemented, these local districts will need to be included in the planning, implementation and educational process. Their local knowledge of the history of the watershed is an integral component of understanding the present and historical hydrology of the bayous and streams in the area. They are also key in gaining support of the local landowners for implementing a new, possibly more innovative method to stabilize the streambank and protect the stream.

LOUISIANA DEPARTMENT OF ENVIRONMENTAL QUALITY

The LDEQ also has an important role in this section of the NPS Program. The NPS Unit can work with the local drainage boards, police juries and conservation districts on demonstration projects and educational programs that illustrate new methods of streambank restoration and protection. They can sponsor workshops for federal, state and local government entities on bioengineering and stream morphology. In addition to facilitating change in methods of hydromodification, LDEQ can utilize the 401 Water Quality Certification as a tool to encourage the utilization of these best management practices at the local level.

LOUISIANA DEPARTMENT OF NATURAL RESOURCES/COASTAL MANAGEMENT DIVISION

The LDNR/CMD through its 6217 program will develop a subdivision evaluation guide for use by CMD permit analysts and residential developers specifying BMPs needed to control storm water runoff during and after development. The guide will be distributed to coastal parish governments and other appropriate users. Through the distribution and use of this guide, it is expected that sediment pollution due to commercial developed will be effectively reduced.

LOCAL DRAINAGE BOARDS

The local drainage board is often the entity to submit a hydromodification project to LDEQ for certification. The board is typically responding to a request by the local community for improved drainage of their farms or their subdivision, because of flooding problems. The drainage board may also be responsible for maintaining a project that was done by the Corp of Engineers during the past 10 to 50 years. If the Corp conducted a hydromodification project in 1945 to widen or deepen a water body for flood control and drainage, the maintenance responsibilities of the project lies at the local level. Therefore, the drainage board may be getting pressure from both the local community and the Corp of Engineers to maintain the "channel" in order to reduce flooding problems.

POLICE JURIES

The police jury is a local government entity of elected officials that has many responsibilities at the parish level, one of which is drainage. They work closely with the local drainage board to ensure that the parish has limited flooding problems and that the local community's property is protected. The police jury may also be a project sponsor for a hydromodification project.

U.S ARMY CORP OF ENGINEERS

The Corp of Engineers has historically been responsible for maintaining the nation's water bodies for navigation and drainage. Therefore, they are an important partner in the hydromodification activities that are conducted at the watershed level. LDEQ has worked with the Corp of Engineers on these issues for years, but continues to dialogue about ways to improve the understanding of how we can work as partners to protect the state's water bodies and also prevent people and their land from flooding. Through some of their new programs, there are new opportunities to work more closely at the watershed level on hydromodification management measures that are more environmental sensitive to the aquatic and riparian habitat.

FEDERAL CONSISTENCY

Since the NRCS and the Corp of Engineers are the two principle federal agencies involved in hydromodification, LDEQ will work with them on incorporating the streambank restoration strategies into their drainage projects. The U.S. Forest Service has already taken steps to utilize these concepts in their hyrodmodification projects. EPA could work with the state on incorporating these types of best management practices and management measures into hydromodification projects through the 404 permit. LDEQ has opened dialogue and made progress with staff members at the Corp of Engineers about more cooperation on projects that involve nonpoint source pollutants, wetlands and streambank riparian areas. One of the goals for the program is to continue with this dialogue and improve on the understanding of how all agencies can reach common ground on providing adequate drainage for flood protection and also protect and improve the water quality and habitat for fishing and swimming.

PROGRAM TRACKING AND EVALUATION

Tracking of the changes that are made in the methods used to manage streams at the local level will need to be done at the local and the state level. The parish drainage boards and police juries often have the authorities for these types of projects. The Natural Resource Conservation Service (NRCS) and the Local Soil and Water Conservation Districts are also local entities that can assist with tracking the changes that result from these restoration techeniques being utilized more frequently. LDEQ will work with these local entities to determine a method that can effectively track improvements made as a result of the activities outlined here within this section of the NPS Management Plan.

Tracking the water quality improvements that result from increased implementation of hydromodification management practices is the responsibility of LDEQ. Through the basin cyclic water quality monitoring program, watersheds will be sampled once every five years for stream chemistry. This program can report on the long-term changes that result in the stream from improved methods of streambank protection and watershed management. In order to determine the level of habitat improvement that results from these restoration techeniques, LDEQ will need to conduct baseline habitat assessment, which include macro-invertebrate and fish. Follow-up assessments will determine whether these streambank and stream channel protection methods have resulted in measurable water quality and habitat improvements. LDNR/CMD will assist in tracking and evaluation by providing data from the permit/mitigation database on hydromodification/restoration activities that require Coastal Use Permits in the coastal zone.

HOME SEWAGE SYSTEMS

INTRODUCTION

Ground and surface water pollution are major considerations when on-site systems are used. Sewerage treatment and disposal systems should be designed and operated in a manor, which prevents the degradation of ground and surface water quality. Septic tank systems used in undersized lots or where soils are unsuitable for proper treatment of wastewater are subject to undesirable conditions such as widespread saturation of the soil and malfunction of the treatment system. Malfunctioning systems result in sewerage leaching into ground water and into roadside ditches contaminating surface water.

Septic tank systems must be designed so that they are compatible with the geological attributes of the area. If the ground water level is high (less than 4 feet below the surface) or if the soil is extremely permeable, the soil will not be effective in removing pollutants and the ground water may become contaminated, resulting in a public health hazard. Many diseases, including infectious hepatitis, typhoid fever, dysentery, and some forms of diarrhea are caused by water and food contaminated with sewerage and can easily be spread by flies.

Septic tank systems normally consist of two components, a treatment unit and a disposal unit. The septic tank and soil absorption system is the most common individual waste disposal system used in Louisiana. A properly designed septic tank consists of a buried, watertight, multiple compartment tank, usually of concrete material, equipped with inlet and outlet devices and scum control baffles. The absorption system consists of a trench or bed 1 to 5 feet deep containing 6 inches or more of crushed rock or gravel overlaid by a system of perforated distribution piping. This is covered with an additional layer of rock, which is then covered by a suitable, semi-permeable barrier to prevent backfill from penetrating the rock. Proper construction of these systems is an important component in keeping the system functioning properly. Various other types of on-site treatment facilities available include sand filters, aerobic package treatment plants, disinfection units, nutrient removal systems, and wastewater segregation and recycle systems. Other disposal systems available include evaporation systems, aerobic package treatment plants, irrigation systems, and systems that discharge directly into surface waters.

One of the main problems with using conventional septic tank soil absorption systems in Louisiana is that 87 percent of the soil associations in Louisiana are considered inadequate for conventional septic tank systems as determined from the Soil Limitation Ratings for Sanitary Facilities (LDOTD, 1981). Another major component to the pollution caused by septic tank systems is inadequate enforcement of the State Sanitary Code. The State of Louisiana currently has regulations concerning private sewerage disposal systems under the State Sanitary Code (LHHRA, 1974) and the Department of Health and Hospitals (DHH) (LR, 1980). A majority of the sanitarians expressed concern that there is control over new septic tank systems being installed, but there are extensive problems with monitoring the maintenance of existing systems.

VARIOUS BMPS FOR HOME SEWERAGE

INTRODUCTION

BMPs for home sewerage consist of proper choice of septic system. Residents must consider soil type, drainage, loading and use, and maintenance. A list of various septic systems is list in the BMP section of this document.

ACHIEVING GOALS

EDUCATIONAL PROGRAMS

There are several issues or program activities that need to be addressed to reduce the water quality problems that are associated with home sewerage systems. One of the most important steps is continued education of the homeowner about how his/her home sewerage systems works. Most homeowners have no idea how to maintain their home sewerage system for maximum efficiency. A second aspect of the statewide program that needs to be addressed is the lack of inspection of home sewerage systems. The local parish sanitarian office typically does not have sufficient staff to inspect all of the systems across the parish. Even if the system was inspected, it is often difficult to force an action to correct the problem. LDEQ and LDHH are working together to ensure that more education about the problems that these systems cause to water quality across the state will result in more stringent regulations on maintenance of new and existing home sewerage systems.

The Louisiana Department of Environmental Quality (LDEQ) has worked with the Louisiana Department of Health and Hospitals on statewide educational programs aimed at reducing fecal coliform bacteria and nutrients from home sewerage systems. An educational brochure and video were produced that focused on the various types of home sewerage systems that are approved for use in Louisiana. Each type of system was explained along with maintenance requirements recommended to keep the system functioning properly. A maintenance checklist was also included so that the homeowner could keep a record of the steps that had been taken to clean the system out or to have it repaired.

The educational video has been reproduced and distributed across the state in parish offices of the Department of Health and Hospitals and the Louisiana Cooperative Extension Service. These materials are important components for the statewide educational program on home sewerage systems.

The primary goals of the Home Sewerage Statewide Educational Program are to continue to work with the Department of Health and Hospitals and parish governments on more effective inspection programs to ensure that the regulations, which require home sewerage systems to function properly are enforced. Implementation of the short term and long term objectives described above should result in an increased level of compliance across the state and a 50% reduction of fecal coliform problems from home sewerage systems during the next 10-15 years.

PUBLIC PARTICIPATION

PROGRAM TRACKING AND EVALUATION

Tracking installation and maintenance of home sewerage systems is labor intensive job that requires sufficient staff to conduct inspections. The Nonpoint Source Unit will work with the Parish Sanitarian Office in watersheds across the state where home sewerage systems have been identified as contributing to use impairment. Through this partnership, LDEQ could provide federal funds to expand their present staff capabilities for home sewerage system inspection for a three-year period. LDHH staff would inspect existing home sewerage systems to determine if they function properly and work with the homeowner to correct any problems that are identified. These staff would also assist in establishing a parish-wide database to record the inspections and track progress in correcting problems that have been identified through the inspections. LDEQ will report on the results of this project through semi-annual and annual reports that are submitted to EPA.

- Select a pilot parish [based on the 303(d) listed waters] to implement the home sewer inspection and tracking program (short-term);
- Work with the Parish Health Sanitarian Office to determine the extensiveness of the inspections and a timeline to complete them (short-term);
- Assist the parish office in establishing a computer tracking system that identifies where inspections have been made, problems identified, actions taken and timeline to correct the problems (short-term);
- Utilize federal funds to support this pilot project through additional LDHH staff for conducting the inspections, establishing the computer tracking system and working with the homeowner on correcting the problems that were identified through the inspection process (short-term);
- Link results of parish-wide sewer inspection and tracking program with in-stream water quality improvements (short and long-term);
- Report results of the pilot project to EPA on a semi-annual and annual basis (short-term);
- Submit a final report that summarizes the results of the project to EPA (short-term);
- Determine if the project was successful and transfer to other priority watersheds if it proves to be an effective mechanism to reduce the fecal coliform problems associated with home sewerage systems (long-term);
- Work with LDHH to determine if this program can become established as a statewide program that is supported through a combination of federal and state funds (long-term).

Various BMPs for Agriculture, Urban, Hydromodification, and Home Sewerage

AGRICULTURE

The source and publications for agriculture BMPs are far more numerous and varied than urban, hydromodification, and home sewage. Information is provided at the end of this document on conservation tillage, pesticide, fertilizer, and herbicide management. References for filtration strips, water management, and many other management options are included.

Urban Stormwater Treatment

URBAN BMPS

1. Wet ponds - stormwater runoff is directed into an artificially constructed or enhanced natural pond, where a permanent pool of water is maintained. During a storm event, the pool volume is increased until the capacity is exceeded. When this occurs, excess runoff is discharged through an outlet or emergency spillway. Wet ponds can remove suspended solids, total phosphorus, total nitrogen, and trace metals.

2. Infiltration practices - Examples of infiltration BMPs include infiltration basins, trenches, leaching facilities, dry wells, and leaching catch basins. These practices should be used in conjunction with a system of BMPs for their effectiveness. Infiltration BMPs can remove suspended solids, trace metals, total nitrogen, total phosphorus, BOD, and bacteria.

3. Vegetated practices (filter strips, grassed swales, basin landscaping) - vegetative practices are used primarily to reduce the velocity of stormwater runoff in an attempt to promote infiltration and settling of suspended solids and prevent erosion. Used alone, these BMPs usually cannot treat stormwater sufficiently; therefore, they are generally part of a system containing other BMPs, where they act to remove suspended solids from runoff before more intensive treatment. Vegetative BMPs remove suspended solids, organic material, nutrients and trace metals.

4. Constructed Wetlands - these systems can treat stormwater runoff effectively because they combine the pollutant removal capabilities of structural stormwater controls with the flood attenuation provided by natural wetlands. These systems can remove suspended solids, nutrients, oil and grease, bacteria and trace metals.

5. Riparian Reforestation - reforestation/revegetation along urban stream corridors can be included as a practice in conjunction with BMP installations. These practices need to be incorporated in many urban areas as natural filters for urban nonpoint source pollutants. They also provide recreation space in urban settings and contribute to stream restoration. The concept of incorporating vegetative areas into project designs and utilizing existing areas to establish small riparian forests or buffer strips is one of the most effective and inexpensive source controls that adds aesthetic qualities and wildlife habitat in addition to its usefulness as a pollution control measure.

URBAN RUNOFF COLLECTION - DISTRIBUTION

1. Sheet Flow - usually requires only grading and seeding during construction.

2. Grass Swales - grassed low areas graded at a minimum of 4:1 side slopes. They are a shallow grass covered channel, rather than a buried storm drain that is used to convey stormwater. Grass channels are mostly applicable in residential areas. They require shallow slopes, and soils that drain well. Often grass swales are used to provide "pretreatment" of runoff to other controls, particularly infiltration devices.

3. Filter Strips - similar in concept to grass swales, but are designed to distribute runoff across the entire width and result in an overland sheet flow. These strips should have relatively low slopes, adequate length, and should be planted with erosion resistant plant species. They are often used as pretreatment for other BMPs, for example, by being placed in the flow path between a parking lot and an infiltration trench.

4. Oil and Grease Filtering Catch Basins and Oil and Grease Separators - structures designed to collect and distribute runoff coming from parking areas and other areas with high vehicle use. They rely on the principle that oil floats on water, and most remove petroleum products through a specially designed "T" outlet. Separators are maintenance-intense devices:oil and grease must be removed periodically or these substances will become resuspended or re-emulsified and sidecharged through the "T" outlet during subsequent storms. Traps can also be flooded during particularly intense storms, allowing separated oil to flow freely. Coalescing plate oil separators work well under certain conditions, but they are expensive to install and maintain. Still they represent a promising techenology for specific areas where petroleum products are routinely released to the ground surface.

5. Raised Catch Basins - catch basins constructed so that the top lip of the catch basin is raised 1 to 2 inches above the surrounding swale or surface elevation.

6. Dual Compartment Catch Basins - similar to other catch basin designs except that these contain multi-compartments.

7. Dry Wells-Seepage Pits - cavities dug into the ground and filled with gravel or rocks. These work on the principle of returning stormwater directly to the groundwater. One nationwide study found these infiltration devices to be effective when accompanied by sound design and maintenance, although they have the potential for contaminating groundwater if the stormwater they collect and conduct is contaminated. Since clogging is a problem, infiltration devices can only be used in areas where the soil is very permeable. (This BMP would be considered a Class B injection well if the well diameter is less than the depth, and may be subject to the conditions of Class 5 regulations, currently in draft form).

8. Detention Ponds - ("dry ponds") a water impoundment made by constructing a dam or embankment or by excavating a pit to detain stormwater and discharge a controlled volume. Detention basins hold back a portion of the runoff, delaying release to receiving waters and preventing flooding. The settling out of contaminants from runoff that occurs during detention improves water quality. Extended detention ponds use modified outlet structures to release water at a slower rate, greatly enhancing their ability to control sediment. The

effectiveness of either type of detention ponds is reduced, however, when maintenance is neglected. Common problems include blocked outlets, accelerated sedimentation, and standing water in "dry" areas. The Metropolitan Washington D.C. Council of Governments has estimated the cost of detention basin maintenance at approximately $300-500 per maintained acre per year.

> a. Extended Detention Ponds - these basins employ an outlet structure that will cause most storm water to pond in the basin. Following a storm, these basins drain in about 24 to 40 hours and will be dry at all other times. The outlet structures may be either perforated risers or subsurface drains. They provide a practical techenique for retrofitting dry ponds to obtain water quality benefits, and can provide particulate removal efficiency equivalent to that of wet ponds. (Detention ponds may need a liner to protect ground water, based on determination of Ground Water Protection Division).
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> b. Retention Pond - ("wet ponds") a water impoundment made by constructing a dam or embankment or by excavating a pit to retain stormwater and discharge a controlled volume. These are similar to detention basins but are designed to retain a portion of the runoff, "saving" this water for later recharge of streams or allowing it to evaporate during dry seasons. As ponded runoff infiltrates the ground, pollutants may be filtered out or adsorbed onto soil particles. Routine maintenance costs are also similar to those of detention basins, although EPA has found that the cost of constructing these controls may be as much as 40 percent higher than the cost of detention basins. Removal efficiency depends on the size of the basin and the area draining into it. Efficiency may be enhanced by the use of a device upstream of the basin that intercepts the first flush of sediment and other pollutants during a storm.

9. Basin landscaping - Basin landscaping can be addressed during early development of a watershed and can have a significant effect on the control of NPS pollutants. The objectives of basin landscaping include but are not limited to minimization of impervious surface area; protection and utilization of existing wetlands; provision for green-belt buffers along stream banks; routing of runoff flow through vegetated areas and away from erosion-prone steep slopes. Careful selection of vegetation most suitable for site conditions has an important bearing on physical appearance and the long-term performance of basin landscaping.

10. Parking Lot Storage - use impervious parking areas as temporary impoundments during rainstorms. Parking lot drainage systems can be designed to temporarily detain stormwater in special designated areas, and release it at a controlled rate. The objective is to protect downstream areas from increased flooding, stream channel degradation and/or combined sewer overflows caused by urban development. It is important to minimize potential safety hazards and inconvenience to motorists and pedestrians.

11. Parking Lot Planting Areas - areas within a parking lot set-aside for plants and shrubbery.

12. Building Setback - buildings and other structures associated with development projects should be set back from marshes or other waterfront locations.

13. Conventional Flow Regulators - mechanical devices in stormwater conveyance and storage facilities to provide control of the volumes, velocities, and directions of fluid flows in order to maximize the operating efficiencies of these systems (static regulators, semi-automatic dynamic regulators, and automatic dynamic regulators.

14. Fluid Flow Regulators - innovative self-powered and controlled fluid flow regulator which provides numerous advantages over conventional flow regulators, among them lower installation cost, a greater range of flow control, and less maintenance. Depending upon the design and application, these devices can be used to selectively divert the first flush of a storm into treatment facilities or temporary storage areas: to automatically proportion runoff flows between receiving streams and retention or detention facilities; or to provide increased operating efficiency of storm and combined sewers during wet weather flows. All of these functions serve to reduce the impacts on receiving waters.

URBAN PAVING MATERIAL

Minimize Impervious Surfaces - many surfaces can be made pervious or modified to reduce the impact of flooding during rainy weather. Reduction in the amount of impervious surfaces lowers the amount of surface water runoff, and, therefore, can achieve a reduction in pollution.

1. Pervious Asphalt Paving - pervious asphalt allows water to pass through the surface and is infiltrated into the subsurface soils. This may be expensive and may require some maintenance to prevent clogging and loss of effectiveness.

2. Paving Blocks - used to support automobile traffic and still leave enough unpaved area to allow water infiltration.

3. Other pavement surfaces (coquina, gravel oyster shell) surfaces suitable for use in lightly traveled areas.

Structural BMP's (i.e. retention basins) usually attempt to deal with stormwater problems at their source through artificially constructed systems. They are often used when vegetation alone will not provide the necessary degree of protection, or when flows concentrate in a specific area.

Nonstructural BMP's (i.e. grass swales) take into consideration site factors and use features of the natural drainage system, vegetative controls, and the modification of everyday land use practices to achieve similar ends. They may prove to be ineffective as remedial measures, but are best incorporated into designs of any future stormwater management system.

Home Sewerage Systems Approved for use in Louisiana

SEPTIC SYSTEMS

A septic tank is basically a watertight tank constructed of steel, concrete or other approved materials in which the suspended solids of sewerage settle out and are largely changed into liquids or gases by microbial degradation. The remaining residue in the tank is a black semiliquid sludge that must be removed periodically from the tank. Although relatively few disease organisms should be present in the sludge material, precautions should be taken in cleaning the tank and the sludge material safely disposed. Cleaning and disposal of sludge material from septic tanks can be provided by commercial services. These services are controlled by a permit system, required by local parish health units in accordance with Chapter 13 of the State Sanitary Code.

A series of single compartment septic tank systems or a multiple compartment septic tank system has proven to be more effective than the individual septic tank system, but the individual septic tank system is still acceptable. Information on the velocities of flow through the system and the types of tees and baffles required for the inlet and outlet valves are included within the description of septic tank systems. Estimates of capacities and size for a system are also included, with recommendations for the types of materials that should be utilized in their construction. Recommendations are also made for inspection and cleaning of the systems with the optimum time period being every two to five years, although the average period between cleaning was estimated to be between eight and ten years.

SEPTIC TANK EFFLUENT

Although many people believe that discharge waters from a septic tank system are clean and pure, this is not the case. The effluent of the liquid discharged from a septic tank system is classified as primary treatment, usually being foul and potentially dangerous, often containing disease-causing bacteria. Therefore discharge of septic tank effluent are not allowed in street gutters, surface ditches, or streams, according to regulations in the Louisiana State Sanitary Code. The method recommended for treatment of septic tank effluent is a soil absorption trench system. If the absorption trench is not possible due to poor soil or drainage conditions, then a small oxidation pond or a sand filter bed can also be utilized for secondary treatment of septic tank effluent.

ABSORPTION TRENCH FIELDS

The recommended method of treatment for septic tank effluent is an absorption trench or "subsurface irrigation" field, when suitable soil conditions exist. The absorption trench consists of a system of covered, gravel-filled trenches into which the septic tank effluent is applied, allowing for seepage of the liquid into the soil. Within the soil, the microbial populations degrade the organic matter in suspension or in solution to the mineral compounds, similar to the processed involved in decomposition of animal waste manure in a plowed field. Basically three conditions must be met in order for absorption trenches to be a suitable method of secondary treatment:

1. The soil percolation rate should be within the acceptable range, dependant on soil porosity or permeability,
2. The maximum elevation of the ground-water table should be at least two feet below the bottom of the proposed trench,
3. Clay formations or other impervious strata should be at a depth greater than four feet below the bottom of the trenches.

If these three conditions are not met, then an alternative method of treatment should be utilized (Chapter 13; Section A.III.) In order for a determination to be made on the suitability of the soil for an absorption trench field, a percolation test should be done. The procedure for conducting this test is given within the sanitary code (Chapter 13:A:3.4). The code also describes specifications required for adsorption trenches associated with individual residences (Chapter 13:A:3.5-3.18) Absorption trenches shall not be located:

A. beneath driveways, parking or other paved areas;
B. in areas that may be subjected to passage or parking of heavy equipment or vehicles, or storage of materials;
C. beneath buildings or other structures.

OXIDATION PONDS

An oxidation pond may be utilized in conjunction with the septic tank to treat sewerage effluent. The oxidation pond is a shallow pond that is designed specifically treat sewerage by natural purification processes under the influence of air and sunlight. The stabilization process consists primarily of interactions of bacteria and algae. The bacteria digest and oxidize the constituents of sewerage and render it harmless and odor free. Algae utilize carbon dioxide and other substances resulting from bacterial action and through photosynthesis produce the oxygen needed to sustain the bacteria in the treatment process. During the detention period, the objectionable characteristics of the sewerage largely disappear. Specifications for construction of the oxidation ponds are given in Chapter 13: Section IV of the State Sanitary Code.

SAND FILTER BEDS

A second method for treatment of septic tank effluent is a deep-type sand filter bed. In this method, treatment is accomplished by microbial action in the sand filter bed, where suspended solids of the septic tank effluent are trapped by filtration. It is important for the sand bed to remain aerobic if degradative processes are to occur, therefore the sand surface needs to remain in contact with the air for as long as possible. This can best be accomplished by no cover being allowed on the sand bed system, but that is not usually acceptable to the landowner so a course gravel cover of not more than six inches in depth is permitted. No other cover is acceptable. Recommendations on the size and construction specifications for the sand filter bed are included in Chapter 13:5.2-5.11 of the State Sanitary Code.

MECHANICAL WASTEWATER TREATMENT

In the cases where septic tank systems can not be expected to function properly due to unsuitability of soils (based on results of the percolation tests), a mechanical waste water treatment plant is allowed. Mechanical waste water treatment plants are small plants capable of providing primary and secondary sewerage treatment. They are considered aerobic treatment systems that do not require previous treatment in septic tanks. Mechanical treatment plants must strictly comply with National Sanitation Foundation International Standard, NSF 40-1996 for Residential Wastewater Treatment Systems (Class

I Systems) as revised May 1996 and published by NSF International, P.O. Box 130140, Ann Arbor, Michigan 48113-0140 USA, and as has been approved by the American National Standards Institute, 11 West 42nd Street, New York, New York 10036 as standard ANSI/NSF 40-1996, revised May 28, 1996. Determination of compliance with NSF Standard Number 40 requirements shall be the responsibility and sole authority of the State Health Officer acting through the Office of Public Health.

PUMPING STATION

A pumping station is often required when a sand filter bed and/or an oxidation pond is utilized as a means of secondary treatment for a septic tank system, especially in areas with flat terrain. Due to the corrosive nature of septic tank effluent, pumps or pumping stations built especially for these effluents are required. Construction specifications for the pumping stations are included in Chapter 13: Part VIII of the State Sanitary Code. These specifications include the dimensions and type of materials the should be used for the culvert pipe, the type of pump and the pump housing that is required and the type of cover that should be used for the top of the pump station, allowing for maintenance of the pump.

SANITARY PIT PRIVY

When a dwelling is not served by water under pressure, water carriage waste systems, as have been previously covered, can not be used. In these cases, a pit privy is required for waste disposal. The pit privy system must be located so that they will not pollute domestic, private, or public water supplies. Therefore, they must be located downgrade and at least fifty feet away from water wells and water supply lines. Pit privies must also be located at least four feet from any fence, ditch, or building to give room for a proper earth mound. They must be housed as separate units and located at least ten feet from the property line. Specifications for construction and maintenance of an approved privy system are included within a pamphlet entitled, "Louisiana Type Sanitary Pit Privy, which can be obtained through the Division of Environmental Services within the Office of Health Services and Environmental Quality.

MICROBIAL ROCK FILTER

One alternative type of individual waste water treatment system that the Department of Health and Hospitals has investigated and that Region 6 EPA supports is the microbial rock plant filter. The system was originally designed Dr. W. C. Wolverton, a research scientist at the Stennis Space Center, to be used for recycling wastes in a space station on the moon. The techenology has been evaluated and implemented during the past 10 years for use in individual and community waste water treatment systems within the United States. Thirty-seven of these systems are presently functioning or are being planned for construction in Louisiana. The design utilizes the concept of synergistic effects of naturally occurring plant and rock microbial populations to reduce biochemical oxygen demand (BOD) in septic tanks and oxidation lagoon effluent. The systems have been shown to reduce BOD from 110-50 mg/L to 10-2 mg/L in 24 to 48 hours. Toxic organic and metals have also been reduced through the use of these systems, with measurable reductions in fecal coliform levels.

The scientific basis for the microbial rock plant system for waste water treatment is growth of plants and microbial populations living on and around plant root systems and the rock filter.

Once the microbial populations are established on the aquatic plant roots and the rocks in the filter, a symbiotic relationship is formed with the higher plants, resulting in increased degradation rates and removal of organic chemicals from the waste water effluent surrounding the plant roots and the rock system. The degradative products of the organic are absorbed by the plants and utilized along with nitrogen, phosphorus, and other minerals as a food source. Microorganisms also use some or all of the metabolites released through the plant roots as a food. Each ecological system, using the other's waste products, provides for a biogenerative habitat to be sustained for accelerated removal of organic from waste water. Charges associated with the plant root hairs attract the colloidal particles, such as suspended solids, with opposite charges causing them to adhere to the plants where the solids are being removed by the rocks, then digested and assimilated by microorganisms. This system increases the density of the microorganisms and accelerates the biological activity.

FECAL COLIFORMS IN THE BAYOU TECHE

INTRODUCTION

Fecal coliform bacteria live in large numbers the intestines of warm-blooded animals. They aid in the digestion of food and the presence of them in an aquatic environment indicates that the water has been contaminated with the fecal material of man or other animals. If high numbers are found in a waterbody, the system may be contaminated with pathogens or disease producing bacteria or viruses, which can exist in fecal materials. Some waterborne pathogenic diseases include typhoid fever, viral and bacterial gastroenteritis, and hepatitis A. The presence of fecal contamination is an indicator that a potential health risk exists for individuals exposed to this water. Fecal coliform bacteria may occur in ambient water as a result of the overflow of domestic sewage or nonpoint sources of human and animal waste.

The Louisiana fecal coliform standards for primary contact is below:

> "…the fecal coliform content shall not exceed a log mean of 200/100mL, nor shall more than 10% of the total samples during any 30-day period or 25% of the total samples collected annually shall exceed 400/100mL. These primary contact recreation criteria shall apply only during the defined recreational period of May 1st through October 31st. During the non-recreational period of November 1st through April 30th, the criteria for secondary contact recreation shall apply"

The standard for secondary contact reads similarly:

> "Based on a minimum of not less than five samples taken over not more than a 30-day period, the fecal coliform content shall not exceed a log mean of 1000/100 mL, nor shall more than 10% if the total samples during any 30-day period or 25% of the total samples collected annually exceed 2,000/100ML".

And the standard for drinking water supply is written as follows:

"The monthly arithmetic mean of total coliform most probable number shall not exceed 10,000/100 mL, nor shall monthly arithmetic mean of fecal coliforms exceed 2,000/100 mL."

TMDL FINDINGS:

The Bayou Teche and its tributaries fail in both primary and secondary contact recreation for fecal coliforms, however, the bayou meets criteria for drinking water supply. The load reduction needed to meet the water quality standard for primary contact recreation in the watershed during the recreational period (May 1 – October 31) is 83% reduction. For secondary contact during the non-recreational period (November 1 – April 30), the load reduction needed is 73% reduction.

Table 1.1 Fecal coliform counts, criteria, loading, and flow in the Bayou Teche during winter and summer seasons.

MEASUREMENT	MAY TO OCTOBER	NOVEMBER TO APRIL
Flow at Adeline	383 ft^3/sec	878 ft^3/sec
Average fecal coliform count	1,675 cfu/100ml	200 cfu/100ml
TMDL fecal coliform criteria	200/100mL	1,000/100mL
TMDL % reduction required	62%	In compliance
Average loading per day	1.57 E13 cfu/day	1.87 E12 cfu/day

POINT SOURCES

There are 17 known sanitary waste facilities discharging into the Bayou Teche and its tributaries. The combined flow for all these discharges is 5,277,000 gpd. More stringent limitations on point sources of fecal coliforms will not be required. LDEQ regulations already require that point discharges of sanitary waste must maintain a fecal coliform count the on effluents of 200 cfu/100 mL. In other words, point sources already meet criteria at the end-of-pipe. At 200 cfu/100mL, the contribution of all point sources to the Bayou Teche is 4.00 E10 cfu/day.

NPS SOURCES OF FECAL COLIFORMS

Fecal coliforms are pretty much everywhere and can be found in high numbers in surface waters after major rain events. Sources of fecal coliforms include faulty septic systems, sewer overflow, municipal trash, urban areas, bovine grazing pasture, animal feedlots, and wildlife such as waterfowl, mammals, and even cold-blooded animals discharge fecal coliforms. Precipitation can transport fecals materials as they can attach to soil particles and organic debris and run into waterways. Associating coliform levels with rainfall, rainfall intensity, or turbidity may be misleading, however, other watershed variables such as population density or presence of animal husbandry operations such as animal feedlots may be better indicators to predict of coliform levels in a watershed (Glenne, 1984) (Chang, 1999) page 76.

Fecal counts drop sharply during the winter months, as much as 90% (Schueler et al. 2000), in many of the surface waters around the country; however, the rice/crawfish ponds and flooded fields in the Bayou Teche watershed are frequented by a multitude of migratory birds during the winter months. Fecal coliform levels rise during the winter months as the migratory birds settle in the region during the winter months or as they pass on through to destination further south. Upon return many of the migratory birds will again utilize the flooded fields in the Bayou Teche watershed on their trip back up to the northern latitudes.

WASTE LOAD ALLOCATION

LDEQ does not know the relative contribution of the various NPS sources of fecal coliforms in the Bayou Teche. All we do know is that the point sources are contributing 4.00 E10 cfu/day. If we are going to be able to remediate the high levels of coliforms and bring the bayou within criteria limits, we will have to perform extensive studies to identify the sources. The table below (table ??) represents our knowledge of the sources and the management practices available to mitigate the problem. As you can see, very little is known about the sources of NPS fecal coliforms in the watershed. Extensive research and sampling will be required to understand and mitigate run-off of fecal coliforms in the watershed.

ACHIEVING GOALS IN THE WATERSHED

In order to meet primary and secondary contact criteria in the watershed, LDEQ will have to conduct extensive research to identify the sources of fecal coliforms. Over the next few years we will have to perform DNA testing and standard counts on coliforms at locations near urban areas and agricultural areas. We will need to test surface waters during the winter in the areas were farmers maintain flooded fields for rice and crawfish production so we can determine the relative contribution of the migratory birds that commonly visit the fields. An extensive home-to-home survey will be required to estimate the performance of septic systems in the rural residential areas. Fecal coliforms counts and DNA testing should be performed adjacent to urban areas to determine the relative contribution of pets and municipal waste to the overall problem. As mentioned in the dissolved oxygen section, extensive monitoring will be conducted in agricultural areas adjacent to pasture land and rice and crawfish flooded fields, however, this monitoring will only analyze standard fecal counts. We will need to conduct DNA testing on the fecal samples in the agricultural areas as well as urban areas to pinpoint and quantify the sources. Once we have prepared an accurate account of the sources of fecal coliforms we will revise this implementation plan to reflect the data gathered over the next three years.

The goal is to come up with some plausible BMPs to remediate the sources. After we have assessed the sources of fecal coliforms, we will have to draft a plan to bring the watershed into compliance. We will assess the available BMPs and evaluate the cost. We anticipate being able to identify the hotspots in the watershed and implement the BMPs in those areas. Writing the remediation plan will take approximately two years. Implementing the BMPs will occur over the next 5 years and we will enlist the Dept of Health and Hospitals to manage the faulty septic systems and sewage treatment plants. NRCS and SWCD will help with implementing the agricultural BMPs that are needed to control fecal coliforms running off of pasturelands and row crops. Once LDEQ has analyzed sources of fecals from urban areas, it is anticipate that local universities will participate in the implementation of BMPs to control and manage fecals from pets and municipal wastes. At this time, the cost of BMP implementation and the full extent has not been assessed.

TIME-LINE OF THE EVENTS TO ACHIEVE TMDL GOALS

Jan I can make this one of those nice charts you used before (preferably) or I can put this with the other time lines (DO,TDS) or I could just write a description of the time it will take (10 yrs) at which time

PROGRAM TRACKING AND EVALUATION

LDEQ maintains a surface water quality monitoring program in the Mermentau Basin. The Bayou Teche is sampled every five years to evaluate any improvement or decline in water quality. In 1998, the LDEQ monitoring program sampled the bayou at site 0650 near the mouth of the river just before it joins the Mermentau river. This site will be visited again in 2004 and sampled once a month for one year. Again in 2009, the same site will be sampled for fecal coliforms, DO, and a number of other constituents. These efforts will help track and evaluate the effectiveness of BMPs initiated in the watershed. The LDEQ water quality monitoring program only takes grab samples at the mouth of the bayou which gives no indication of a stage-discharge relationship or concentration of pollutants. This monitoring effort may not clearly describe the effectiveness of implementation measures.

Currently, LDEQ is sponsoring a watershed wide monitoring effort to analyze the effect of agricultural BMPs on water quality in two of the sub-watersheds and in the larger Bayou Teche watershed. This effort is discussed in greater detail in the section on dissolved oxygen, however, fecals and many other constituents will be sampled at 24 sites throughout the watershed. This project will begin in the spring of 2002 and will continue through the year of 2004. These monitoring efforts will sample for coliforms and many other constituents to determine whether agriculture BMPs have any affect on coliform abundance in the waterways. After the research is finish, LDEQ will be able to evaluate the relative contribution of agriculture lands to the overall fecal problem-providing the needed research discussed above is conducted in a timely manner.

As mentioned above, a watershed-wide monitoring project is scheduled to commence the spring of 2002 and continue through 2004. LDEQ proposes to revisit the sites after ten years for follow-up fecal sampling as well as many other constituents. In 2012, LDEQ will sample for coliforms along the Bayou Teche and its tributaries at many of the same sites sampled ten years earlier. LDEQ will sample for one year and hopefully the weather pattern over the year in 2012 will be comparable to one of the years of monitoring event ten years earlier. The 2012 monitoring project will establish a stage discharge relationship as well to insure that the sampling events are comparable to those performed in 2002.

PROPOSED ADJUSTMENTS IF NO IMPROVEMENTS ARE DETECTED

If after ten years no reduction in fecal coliforms counts are detected or if they actually rise, which is entirely possible since coliform abundance is direct correlated to population densities (Chang, 1999), the implementation plan will be revised to require more stringent mitigation strategies. The proposed sampling in 2012 will give a clear indication of the success or failure of our management measures. It is anticipated that new technologies will arise for reducing the runoff of coliforms in both urban and agriculture areas. At this time, it is difficult to determine what adjustment will be made, however, LDEQ will consider the latest technologies for addressing the problem if it does not improve. LDEQ is proposing that in ten years time LDEQ revisits the watershed for a thorough analysis of NPS contribution to the overall pollution problems in the Bayou Teche.

FECAL COLIFORM REQUIRE A 62% REDUCTION DURING THE SUMMER RECREATIONAL PERIOD AND A 0% REDUCTION DURING THE WINTER NON-RECREATIONAL PERIOD						
Source	**Present in watershed**	**Percent of total load**	**Transport and pathway to water system**	**Can we do anything about it?**	**Remediation techniques**	**BMP effectiveness**
Faulty septic systems	Yes, according to (???) approximately ??% of the septic systems are not operating properly	Unknown	Faulty septic tanks drain into ditches	No, it is the responsibility of the Department of Health and Hospitals to monitor and correct home sewerage problems	Install effective septic tank systems	95%
Sewer overflow	Unknown	Unknown	Drains right into Bayou	Unknown	Increase treatment capacity of sewerage system	Sewerage plant will meet criteria at all times
Grazing pasture	Yes, ??% of the watershed contains pasture grazing land	Unknown	Rain events transport fecals overland into waterways	Yes, implement BMPs to prevent bovine discharges from migrating into waterways	Filter strips, livestock drinking wells located in away from waterways	Unknown
Agriculture row crops	Yes, ??% of the watershed contains agriculture row crops	Unknown	Rain events transport fecals overland into waterways	Yes, implement BMPs to prevent sediments and organics which fecal coliforms attach to.	Conservation tillage, filter strips, and other BMPs which reduce sediment runoff	Unknown????
Animal husbandry feedlots	No	NA	NA	NA	NA	NA
Wildlife/migratory waterfowl	Yes, migratory birds double and sometimes triple coliform counts during the winter when they are utilizing the flooded fields in the watershed	Unknown	Waterfowl discharge fecals directly into water or very close to shore	No	None	NA
Urban areas-pets and trash	Yes, ??% of the land areas are urban	Unknown	Rain events transport coliforms	No	Neighborhood retention ponds, artificial wetlands, and buffer zones	Retaining urban runoff in retention ponds and artificial wetlands can result in a 95% reduction of fecal coliforms. The greater the residence time before the runoff reaches the stream system the greater the remediation of coliforms